RI-FS FIELD SAMPLING PLAN ADDENDUM No. 1

Falcon Refinery Superfund Site
Ingleside
San Patricio County, Texas
TXD 086 278 058

Prepared for

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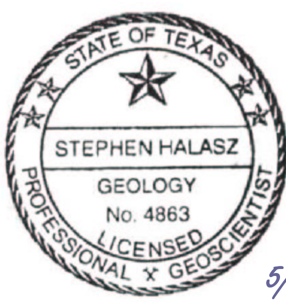
ABBREVIATIONS AND ACRONYMS

API	American Petroleum Institute
AOC	Area of concern
ARAR	Applicable or Relevant and Appropriate Requirements
BG	Background
bgs	Below Ground Surface
BTEX	Benzene, Toluene, Ethylbenzene and Xylenes
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COPC	Chemical of Potential Concern
COPEC	Chemical or Compound or Contaminant of Potential Ecological Concern
CSM	Conceptual Site Model
DQO	Data Quality Objective
DTW	Depth to Water
EB	Equipment Blank
EPA	U.S. Environmental Protection Agency
ERA	Ecological Risk Assessment
FS	Feasibility Study
FSP	Field Sampling Plan
G	Grid Sample
gpm	Gallons Per Minute
GPS	Global Positioning System
HHRA	Human Health Risk Assessment
HRS	Hazard Ranking System Documentation Record, Falcon Refinery
IDW	Investigation-Derived Waste
J	Judgmental Sample
MD	Matrix Duplicate
µg/L	Microgram per Liter
µg/kg	Microgram per Kilogram
mg/kg	Milligram per Kilogram
MS	Matrix spike
MSD	Matrix spike duplicate
MSSL	Medium-specific Screening Level
MW	Permanent Monitor Well
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
NORCO	National Oil Recovery Corporation
NPL	National Priorities List
OU	Operating Unit
PCB	Polychlorinated Biphenyl
PCL	Protective Concentration Limit
PID	Photoionization Detector
PPE	Personal Protective Equipment
PVC	Polyvinyl Chloride

QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
QC	Quality Control
RA	Removal Action
RAW	Removal Action Work Plan
RBSL	Risk Based Screening Level
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RPM	Remedial Project Manager
S	Soil Sample
SD	Sediment Sample
SOP	Standard Operating Procedure
Superior	Superior Crude Oil Gathering
SVOC	Semi-Volatile Organic Compound
SW	Surface Water Sample
TB	Trip Blank
TCEQ	Texas Commission on Environmental Quality
TCLP	Toxicity Characteristic Leaching Procedure
TNRCC	Texas Natural Resources Conservation Commission
TPH	Total Petroleum Hydrocarbons
TRV	Toxicity Reference Value
TW	Temporary Monitor Well
UCL	Upper Confidence Level
USCS	Unified Soil Classification System
VOC	Volatile Organic Compound
VSP	Visual Sample Plan
WBZ	Water Bearing Zone

To the best of my knowledge, after thorough investigation, I certify that the information contained in or accompanying this submission is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Stephen Halasz, Project Coordinator



5/29/2009

1.0 INTRODUCTION

The following Field Sampling Plan (FSP) Addendum, prepared by Kleinfelder, on behalf of National Oil Recovery Corporation (NORCO), utilizes the results of Phase I sampling and defines the sampling and data gathering methods to be used to define the nature and extent of contamination and human and ecological risk for Phase II at the former Falcon Refinery located near Ingleside, San Patricio County, Texas (Figure 1). Specifically, the FSP will include Phase II sampling objectives, sample locations and frequency, sampling equipment and procedures and sample handling and analysis. All work will be performed in compliance with the U.S. Environmental Protection Agency's (EPA) guidance document titled, *Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA.*

Field sampling activities related to the disposal of on-site hazardous materials (referred to as the Removal Action (RA)) at the former Falcon Refinery site will be performed in accordance with the approved FSP dated August 24, 2007.

The Quality Assurance Project Plan (QAPP) and QAPP Addendum are companion documents to this FSP Addendum and provide information concerning the rationale for the sampling strategy, laboratory procedures and the Quality Assurance/Quality Control (QA/QC) procedures to be employed in this FSP Addendum.

Section numbering in this report is similar to the numbering in the FSP. Only sections that requiring updating or are pertaining to Phase II are included.

1.1 Phase II Investigation Overview

Described in this section is the Phase II assessment plan for this FSP Addendum. Details of the methodologies used to perform the activities are described in the Standard Operating Procedures (SOP) provided as Appendix A of the approved FSP.

For Phase I, the number of soil, sediment, groundwater, and surface water judgmental or random grid sampling locations were initially determined by the Site Team and were not based on the distribution of constituents, if any, at the site. Phase I helped to determine the distribution of constituents at the site and served as the basis for this FSP Addendum.

When the data from Phase I were obtained and analyzed, the standard deviation, alpha and beta error rates, width of the gray region, and a threshold value (screening value) were then used in Phase II as input into Visual Sample Plan (VSP) software algorithms to statistically determine the minimum number of samples required to meet the Data Quality Objectives (DQO) for the site.

For human health and ecological risk assessment screening purposes, any chemicals detected at the site above their respective screening levels will be carried forward in the risk assessments required by the National Contingency Plan (NCP), taking into account synergistic effects. For ecological risk assessment screening purposes, bioaccumulative chemicals may need to be carried forward in the risk assessment if found below their respective screening levels.

For both the human health and ecological risk assessments, the maximum detected concentrations will be used for risk screening purposes. The statistically derived 95% upper confidence limit (UCL) of the arithmetic mean (if the sample size is adequate) or maximum concentration (if the sample size is inadequate), whichever is appropriate for a given medium, will be calculated for use as the concentration term in the risk assessment equations following the risk screening process. The statistical methods described in EPA guidance documents for calculating UCLs are based on the assumption of random sampling.

1.1.1 Phase I On-Site Investigation

The following on-site Phase I sampling activities were performed:

- Collected judgmental surface and subsurface soil samples at former operating units (OU) at the north and south sites using a Geoprobe and/or hand sampling device;
- Collected random start grid composite surface and subsurface soil samples from areas of the site not associated with former OUs using a Geoprobe; and
- Installed and sampled temporary monitor wells using a Geoprobe at locations with the highest probability of groundwater impacts. The temporary monitor wells were abandoned prior to demobilization from the site.

1.1.2 Phase I Off-Site Investigation

The following off-site Phase I sampling activities were performed:

- Collected judgmental sediment, surface and subsurface soil samples at background locations in areas located outside the area of probable impact from the site, in similar settings to those being evaluated;
- Collected judgmental surface and subsurface soil at residential locations adjacent to the site;
- Collected random start grid sediment samples in the wetlands;
- Collected judgmental sediment and surface/subsurface soil samples along the active and inactive pipelines leading to the current and former barge dock

facilities; and

- Sampled surface water in the wetlands and bay adjacent to the site.

Provided as Appendix A are figures showing the analytical results of the Phase I sampling and analysis. Data are presented by 1) area of concern (AOC), 2) matrix (groundwater, surface soil, subsurface soil, sediment and surface water), 3) analytical group (metals, volatile organic compounds (VOC) and semi-volatile organic compounds (SVOC) and 4) analysis type (comparison to human health criteria or ecological criteria). Figures are also provided for background sampling.

Mapping criteria included listing chemicals of potential concern (COPCs) having either a single detection above an applicable screening value or a method detection limit above an applicable screening value.

Provided as Appendix B are the analytical results of the Phase I sampling.

1.2 Phase II Investigation

When the data from Phase I were obtained and analyzed, the standard deviation, alpha and beta error rates, width of the gray region, and a threshold value (benchmark human health or ecological screening value) were used in Phase II as input into VSP software algorithms to statistically determine the minimum number of samples required to meet the DQO for the site.

For the VSP evaluation of the minimum number of samples required to meet the DQOs for the site, an alpha error rate of 5% and a beta error rate of 10% were selected to balance the costs of additional samples against the usefulness of additional data for site management decisions. The analyte mean was assumed to be greater than the screening levels (i.e., site assumed to be "dirty"). The analyte standard deviation for each AOC media was used. Due to the nature of the data and analyte screening levels, the data was evaluated using two methods for identifying the width of the gray region (delta) and are described below:

Method 1 calculated delta is the difference between the analyte mean concentration and the screening value. This delta is useful for calculating the number of samples necessary to differentiate between the analyte mean and the screening value. However, when the difference between the mean and the screening value is less than the analyte standard deviation, a very large minimum sample number will be calculated. This method of calculating delta is described in *Guidance on Systematic Planning Using the Data Quality Objective Process*, EPA QA/G4, February 2006, available at http://www.epa.gov/QUALITY/qs-docs/g4-final.pdf. In this case, the screening value less the delta value can be described as the concentration above which decision makers will accept actually "clean" sites will be misclassified as "dirty".

Method 2 delta is calculated independently of the analyte mean as a fraction of the screening value. This type of delta is useful for calculating the sample quantity necessary to differentiate an analyte mean from the screening value when only the analyte standard deviation can be reasonably predicted. However, when delta is less than the standard deviation, a very large minimum sample number will be calculated. For the purpose of evaluating Phase I data for the site, the delta was calculated as one half of the screening value. The range of appropriate values for Method 2 delta is given in the VSP User Guide as 0.2 to 0.95 of the screening value (Visual Sample Plan Version 5.0 User's Guide, September 2007, page 3.7). In this case, delta can be described as the fraction of the screening value above which decision makers will accept actually "clean" sites will be misclassified as "dirty".

Analyte data judged acceptable for minimum sample number calculation in VSP were those with at least four detected concentrations in an AOC media. For example, if at least four detected concentrations were present in AOC-1 Surface Soil, the analyte was evaluated for minimum sample number in AOC-1 Surface Soil. If the analyte was not detected at least four times in AOC-1 Subsurface Soil, it was not evaluated for minimum sample number in that media.

Analytical data flagged with "B", indicating it was detected in analytical blanks, was conservatively evaluated at the reported value without reference to if the analyte was a commonly detected laboratory contaminant or not. Analytical data flagged with "J" or not flagged were evaluated with the reported value. Analytical data flagged with "U", indicating it was not detected at the reported concentration, were divided by two prior to evaluation. Duplicate samples whether detected or not were evaluated at their average concentration, after adjustment for U-flagged values.

The VSP reports of minimum sample size calculations for each AOC media with analytes detected at least four times are presented as Appendix C. Because of formatting limitations within the VSP report function, refer to the beginning of Appendix C for an index of each report's applicable AOC, media, and delta method. Note the VSP software contains at least two errors in its reporting function impacting this work. The most significant error assigns potential new sample locations a concentration of zero for the first analyte listed in the table of analyte screening values prior to calculating the specific analyte's summary statistics for the report. Therefore an "analyte" named "New Location" was entered at the top of the table as a work-around enabling the VSP report to accurately calculate and present subsequent analyte summary statistics[1]. Tables detailing the results of each VSP evaluation are presented

[1] The second software error to impact this work occurs when areas within an AOC contain the same existing sample location (i.e. areas overlap). This results in the report double-counting data from a location and inaccurate summary statistic values. The work-around used was to merge all areas in an AOC prior to data entry. As a courtesy, VSP technical support personnel have been notified of these two software errors and the work-around used for each.

as Appendix D. Appendix D tables present brief summary statistics for each analyte evaluated, the minimum sample quantities calculated by VSP using Method 1 and Method 2 deltas, sample quantities based upon best professional judgment arrived at after further review of the data, and the proposed number of samples to be collected. Table 2 presents a summary of Appendix D proposed sample quantities for each AOC media during Phase II.

For human health and ecological risk assessment screening purposes, COPCs detected at the site above their respective screening levels will be carried forward in the risk assessments required by NCP, taking into account synergistic effects. For ecological risk assessment screening purposes, bioaccumulative chemicals may need to be carried forward in the risk assessment if found below their respective screening levels.

For both the human health and ecological risk assessments, the maximum detected concentrations will be used for risk screening purposes. The statistically derived 95% UCL of the arithmetic mean (if the sample size is adequate) or maximum concentration (if the sample size is inadequate), whichever is appropriate for a given medium, will be used as the exposure point concentration term during risk assessment following the screening process. The ProUCL software available from EPA will be used to calculate the concentration term (Version 4.0, dated April 2007, available at http://www.epa.gov/esd/tsc/software.htm). The statistical methods described in EPA guidance documents for calculating UCLs are based on the assumption of random sampling.

1.2.1 Phase II On-Site Investigation

- Additional surface and subsurface soil sampling;
- Installation of permanent monitor wells;
- Additional groundwater sampling; and
- Characterization of aquifer properties.

1.2.2 Phase II Off-Site Investigation

- Additional sediment sampling in the wetlands and bay;
- Biota sampling;
- Additional surface water sampling;
- Additional surface and subsurface soil sampling; and
- Installation of off-site monitor wells and groundwater sampling.

1.3 Sampling Objectives and Design

This FSP Addendum is based on site-specific DQOs developed from the comprehensive conceptual site model (CSM) and based on EPA and TCEQ guidance documents. EPA's DQO process is an important tool for defining the type, quality, and quantity of data needed to make defensible decisions.

The DQO approach, discussed in the approved FSP, will be followed in this Addendum. Section A7 of the Falcon Refinery QAPP presents the DQOs developed for the Falcon Refinery Remedial Investigation (RI).

During Phase II sampling, newly acquired analytical data will be evaluated to determine if sufficient data have been obtained which meet the sampling and data DQOs for the site. If the objectives have not been met, additional mobilizations and sampling will be presented.

2.0 CONCEPTUAL SITE MODEL

The purpose of the CSM is to identify pathways for COPC transport and potentially impacted media and receptors. In preparing the CSM, data gaps were identified based on the data needs for defining nature and extent of COPCs, conducting the Ecological Risk Assessment (ERA) and Human Health Risk Assessment (HHRA) and evaluating presumptive remedies for the site, if needed. Site-specific DQOs were developed based on the CSM and were subsequently used to develop the QAPP and FSP for the site.

2.1 Physical Profile

The Falcon Refinery site consists of a refinery which operated intermittently and is currently inactive. When in operation, the refinery had a capacity of 40,000 barrels per day and the primary products consisted of naphtha, jet fuel, kerosene, diesel, and fuel oil.

Further specific descriptions of the physical profile are provided in Section 2.1 of the FSP.

2.2 Areas of Concern

Seven areas of concern (AOC) have been identified as potential areas impacted by COPCs. Three AOCs are identified on-site and four are off-site. AOCs are summarized in Table 1 and shown on Figure 2**.** Each AOC is discussed in detail in Section 2.2 of the FSP.

For the purposes of this Phase II investigation, soil sample intervals will be divided into surface and subsurface soil. Surface soil is soil existing at a depth of 0.0 to 0.5 feet below ground surface (bgs). Subsurface soil includes all depths below 0.5 feet bgs.

2.2.1 AOC-1 Former Operational Units (OU)

Included in AOC-1 are: the entire North site; former OU areas of the South site; a drum disposal area; and an area where metal waste was discarded.

Preliminary COPCs to be screened at this AOC included metals, VOCs, SVOCs, polychlorinated biphenyls (PCBs) and pesticides/herbicides.

Potentially affected media include soil and groundwater.

Reports outlining the VSP-calculated minimum sample sizes with human health or ecological screening values as the benchmarks and using both delta methods are presented as Appendix C: Reports 1 through 4 correspond to AOC-1 surface soils;

Reports 5 through 8 correspond to AOC-1 subsurface soils; and Reports 9 and 10 correspond to AOC-1 groundwater.

Detailed summary tables of the VSP calculations are presented as Appendix D: Table D-1 corresponds to AOC-1 surface and subsurface soils with human health screening value benchmarks; Table D-2 corresponds to AOC-1 surface and subsurface soils with ecological screening value benchmarks; and Table D-3 corresponds to AOC-1 groundwater with human health screening value benchmarks.

2.2.2 AOC-2 On-Site Non-Operational Areas

Included in AOC-2 are areas of the refinery not used for operations or storage and have no record of releases.

Although no COPCs were anticipated in AOC-2, the screened COPCs included metals, VOCs and SVOCs.

Potentially affected media include soil and groundwater.

Minimum samples size calculations were not performed for composite samples collected during Phase I. The minimum sample quantity necessary for AOC-2 was evaluated using best professional judgment based upon review of site history and analytical results for the composite samples.

2.2.3 AOC-3 Wetlands

Included in AOC-3 are 1) wetlands immediately adjacent to the site bordered by Bay Avenue, Bishop Road and a dam on the upstream side, 2) wetlands located between Bishop Road, Sunray Road, Bay Avenue and residences along Thayer Avenue and 3) wetlands between Sunray Road, residences along FM 2725, Gulf Marine Fabricators, Offshore Specialty Fabricators and the outlet of the wetlands into the intracoastal.

There is one active and several abandoned pipelines leading from the refinery to the current and former barge dock facilities. During June 2006, the abandoned pipelines were cut, the contents of the pipelines were removed and plates were welded on the pipeline ends to seal them. These activities were performed under the Remedial Action Work Plan (RAW).

Wetland assessment activities will evaluate releases from the refinery, including any unpermitted wastewater effluent discharges, two known pipeline releases, and possible releases from pipelines leading from the refinery to the current and former barge dock facilities.

There have been documented spills of hydrocarbons, waste and volatile organics. As a result, the screened COPCs at this AOC included metals, VOCs, SVOCs, PCBs, herbicides and pesticides.

Potentially affected media include sediment, soil, surface water and groundwater.

Reports outlining the VSP-calculated minimum sample sizes with human health or ecological screening values as the benchmarks and using both delta methods are presented as Appendix C: Reports 11 through 14 correspond to AOC-3 surface soils; Reports 15 through 18 correspond to AOC-3 subsurface soils; Reports 19 through 22 correspond to AOC-3 surface water; and Reports 23 through 26 correspond to AOC-3 sediments.

Detailed summary tables of the VSP calculations are presented as Appendix D: Table D-4 corresponds to AOC-3 surface and subsurface soils with human health screening value benchmarks; Table D-5 corresponds to AOC-3 surface and subsurface soils with ecological screening value benchmarks; Table D-6 corresponds to AOC-3 surface water with human health and ecological screening value benchmarks; and Table D-7 corresponds to AOC-3 sediments with human health and ecological screening value benchmarks.

2.2.4 AOC-4 Current Barge Docking Facility

Included in AOC-4 is the current barge docking facility, which is approximately 0.5 acres and is located on the intracoastal waterway. The fenced facility, which is connected to the refinery by pipelines, is used to load and unload barges. At the time of this report only crude oil passed through the docking facility. Historically however, refined products were also loaded and unloaded at this docking facility.

There have been no reported releases nor is there evidence of spills associated with this AOC. The screened COPCs at this AOC included metals, VOCs, SVOCs, PCBs and pesticides/herbicides.

Potentially affected media include soil and groundwater.

Minimum samples size calculations were not performed for composite samples collected during Phase I. The minimum sample quantity necessary for AOC-4 was evaluated using best professional judgment based upon review of site history and analytical results for the composite samples.

2.2.5 AOC-5 Intracoastal Waterway

Included in this AOC are the sediments and surface water adjacent to the current and former barge dock facility. The screened COPCs at this AOC included metals, VOCs, SVOCs, PCBs and pesticides/herbicides.

Potentially affected media include sediment and surface water.

The three Phase I samples for AOC-5 did not qualify for statistical calculation of minimum sample size which requires at least four detected concentrations. The minimum sample quantity necessary for AOC-5 was evaluated by review of Phase I analytical data and best professional judgment.

2.2.6 AOC-6 Thayer Road

Included in this AOC is the neighborhood along Thayer Road, located across Bishop Road from the refinery.

The screened COPCs at this AOC included metals, VOCs, SVOCs, PCBs and pesticides/herbicides.

Potentially affected media include soil and groundwater.

The three Phase I samples for AOC-6 did not qualify for statistical calculation of minimum sample size which requires at least four detected concentrations. The minimum sample quantity necessary for AOC-6 was evaluated by review of Phase I analytical data and best professional judgment.

2.2.7 AOC-7 Bishop Road

Included in this AOC is the neighborhood along Bishop Road, located across Bishop Road from the North site.

The screened COPCs at this AOC included metals, VOCs, SVOCs, PCBs and pesticides/herbicides.

Potentially affected media include soil and groundwater.

The two Phase I samples for AOC-7 did not qualify for statistical calculation of minimum sample size which requires at least four detected concentrations. The minimum sample quantity necessary for AOC-7 was evaluated by review of Phase I analytical data and best professional judgment.

3.0 SAMPLING OBJECTIVES

As stated in the DQOs for this project, the following study question, included in the QAPP, was formulated for the Site RI:

- Where do preliminary COPCs exist either on- or off-site at concentrations above or below risk-based screening levels (RBSLs) and/or background concentrations along complete exposure pathways for relevant exposure scenarios?

The primary objective of the FSP sampling design is to collect data of sufficient quantity and quality to resolve the study question and support risk assessment and remedy evaluation. The field sampling design for Phase II is summarized in Table 3**.**

The goal of Phase II is to determine the nature and extent of COPCs and to identify COPC migration pathways. Data must be of sufficient quality (including acceptable reporting limits) and quantity to perform an ERA and HHRA for the site in accordance with risk assessment guidance (EPA 1991, 1997, 2000d). Additional data will be collected to support an evaluation of presumptive remedies for the site.

The field sampling design for Phase II (Table 3) is divided into activities which may be conducted concurrently:

- On-site random-start systematic grid (random grid) soil sampling to assess potential presence of COPCs of high toxicity and/or high mobility, define the nature and extent of COPCs, characterize waste to allow for disposal option evaluation in the FS, and evaluate whether COPCs are migrating off-site. The data will be used in the HHRA and ERA.
- On-site OU groundwater investigation to determine the nature and extent of groundwater COPCs. Permanent monitor well data will be used in the HHRA and ERA. Data collected during the on-site groundwater investigation will also be used to update the pathway and receptor analysis presented in the CSMs, if necessary.
- Off-site random grid wetlands and intracoastal surface water and sediment investigation to define the nature and extent of COPCs, provide data to be used in the HHRA and ERA and also be used to update the pathway and receptor analysis presented in the CSMs, if necessary.
- Off-site background surface soil, subsurface soil, groundwater, surface water and sediment investigation to provide data to be used in the HHRA and ERA.

The strategy for characterizing the site is based on site-specific DQOs, which are based on the following media-specific screening levels (MSSLs):

- EPA Region 6 human health MSSLs and TCEQ Tier 1 PCLs for human health risk screening of soil and groundwater. Groundwater ingestion pathways will only apply, upon consultation with the EPA and TCEQ, if the shallow aquifer is of sufficient yield and natural quality to constitute a potable water supply. Soil screening levels (assuming the dilution/attenuation factor of 10 as suggested by the EPA Soil Screening Level guidance document) will be used to evaluate soil-to-groundwater migration potential;

- TCEQ ecological benchmarks for ecological screening of soil, sediment and surface water;

- Texas and Federal Surface Water Quality Criteria for human health screening; and,

- Other applicable or relevant and appropriate requirements (ARARs).

A complete list of all human health and ecological screening levels (benchmarks) are provided as Appendices E and F of the FSP.

Each of the field sampling activities and the data collection requirements are discussed in the following sections.

3.1 On-Site Random Start Grid Locations AOC-1

A total of 24 random start grid sample locations (four from the North site and 20 from the South site) will be used to assess areas suspected of having had an historical release and discolored areas within former OUs (Figure 3). This area has been designated as AOC-1. The basis of decision for the proposed number of additional soil samples within AOC-1 is summarized in Table 2 with details presented as Appendix D, Tables D-1 and D-2.

There are four random start grid locations (G2-01S – G2-04S) at the North site to characterize possible COPCs in the soil as a result of releases from product storage, pipelines, the former oil and fuel storage racks, storm water run-off, the adjoining Plains site and a former surface impoundment.

There are 20 random start grid sampling locations (G2-05S – G2-24S) at the South site to characterize possible COPCs in the soil as a result of releases from product storage, pipelines, drums, debris, storm water run-off, an aeration pond and stained soil.

Due to the shallow depth of the groundwater, which was less than eight feet, two soil samples will be obtained for laboratory analysis from each boring. Samples will be obtained from the surface to 0.5 feet bgs and from the interval with the highest photoionization detector (PID) reading. In the event of no PID readings, a soil sample from the groundwater interface or at a depth of five feet will be obtained. Samples will be analyzed in a fixed laboratory for Phase I COPCs as shown in Table 3. Each boring will be advanced a minimum of five feet below the initial contact with groundwater.

3.2 On-Site Random Grid Locations AOC-2

The sampling objectives for non-OU on-site soil sampling include determining the nature and extent of COPCs and collecting sufficient data of appropriate quality to assess site risks to either human or ecological populations.

During Phase I, composite sampling was performed and only arsenic was detected above the appropriate screening level. Several constituents were analyzed below the MDL. However, the MDL exceeded screening criteria.

There are four random start grid sampling locations (Figure 4) at AOC-2 (G2-25S through G2-28S) selected by the VSP. The basis of decision for the proposed number of additional soil samples within AOC-2 is summarized in Table 2. AOC-2 is comprised of non-OU areas of the site having no history of releases. Samples will be obtained from the surface to 0.5 feet bgs and from the interval with the highest photoionization detector (PID) reading. In the event of no PID readings, a soil sample from the groundwater interface or at a depth of five feet will be obtained. Discrete surface and subsurface samples will be obtained from two sample locations and will be analyzed in a fixed laboratory for Phase I COPCs as shown in Table 3.

3.3 On-Site Random Grid Locations AOC-4

The sampling objectives for AOC-4 on-site soil sampling include determining the nature and extent of COPCs and collecting sufficient data of appropriate quality to assess site risks to either human or ecological populations.

Similar to AOC-2, composite sampling was performed at AOC-4. Sampling results indicated several COPCs detected above screening criteria. For Phase II, five random start grid sampling locations (Figure 5) have been selected at AOC-4 (G2-29S – G2-33S). The basis of decision for the proposed number of additional soil samples within AOC-4 is summarized in Table 2. Samples will be obtained from the surface to 0.5 feet bgs and from the interval with the highest photoionization detector (PID) reading. In the event of no PID readings, a soil sample from the groundwater interface or at a depth of five feet will be obtained. Discrete surface and subsurface samples will be obtained from five sample locations and will be analyzed in a fixed laboratory for Phase I COPCs as shown in Table 3.

3.4 On-Site Groundwater Locations

The objectives of the on-site groundwater investigation are to determine whether site activities have impacted the shallow aquifer or deeper aquifers and to characterize basic hydrogeology of the site. Groundwater sampling during the Phase II investigation will be accomplished with permanent monitor wells at seven locations.

Locations for the permanent monitor wells (Figure 2) were selected by VSP using a random start grid pattern, which includes two at the North site (MW01-01 – MW01-02) and five at the South site (MW01-03 – MW01-07). The basis of decision for the proposed number of additional groundwater samples within AOC-1 is summarized in Table 2 with details presented as Appendix D, Table D-3. Groundwater samples will be analyzed in a fixed laboratory for Phase I COPCs as shown in Table 3. The groundwater data will be used to evaluate human health risk via the groundwater pathway and may be used to evaluate ecological risk through groundwater discharging to surface water. Monitor well installation, surveying and groundwater sampling will be conducted in accordance with the protocols discussed in Appendix A of the FSP.

3.5 Off-Site Random Grid Sediment Locations AOC-3

The sampling objectives for off-site sediment sampling include determining the nature and extent of contamination and collecting sufficient data of appropriate quality to assess site risks to either human or ecological populations.

The six random start grid sampling locations (G2-01SD - G2-06SD) were selected utilizing VSP (Figure 6). The basis of decision for the proposed number of additional sediment samples within AOC-3 is summarized in Table 2 with details presented as Appendix D, Table D-7. Analysis of Phase I results indicated no additional sediment sampling was necessary; however, six locations have been selected to confirm Phase I results and to again attempt to achieve MDLs lower than screening criteria.

Samples will be obtained from sediment, or soils if random wetland locations are not inundated, from the 0.0 to 0.5 foot interval and will be analyzed in a fixed laboratory for Phase I COPCs as shown in Table 3.

3.6 Off-Site Random Grid Locations AOC-5

The sampling objectives for off-site sediment sampling include determining the nature and extent of COPCs and collecting sufficient data of appropriate quality to assess site risks to either human or ecological populations.

Due to several detections above screening criteria, seven random start grid sampling locations (G2-07SD - G2-13SD) were selected utilizing VSP (Figure 7). These additional samples will be combined with the three results from Phase I sampling for a total of 10 samples to improve the strength of statistical analysis. The basis of decision for the proposed number of additional sediment samples within AOC-5 is presented in Table 2.

Samples will be obtained from the sediment from the 0.0 to 0.5 foot interval and will be analyzed in a fixed laboratory for Phase I COPCs as shown in Table 3.

3.7 Off-Site Surface Water Samples AOC-3

Surface water samples will be obtained from 16 locations within AOC-3 (G2-01SW - G2-16SW) and analyzed for metals, VOCs, SVOCs, PCBs and pesticides/herbicides. Specific sampling locations will be selected based on surface water conditions at the time of sampling. The basis of decision for the proposed number of additional surface water samples within AOC-3 is summarized in Table 2 with details presented as Appendix D, Table D-6.

The wetlands adjacent to the site are frequently dry and change configuration. Prior to sampling, the surface water area within AOC-3 will be mapped and VSP will be used to select 16 random start grid locations. The RPM will be notified of the selected sampling locations.

Surface water sampling for ecological assessment purposes will be in accordance with TCEQ's guidance document entitled (*Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods; RG-415*). The sampling protocol has been incorporated into SOP 21, which is provided in Appendix E.

4.0 FIELD INVESTIGATION

This section describes the field investigation activities to be performed during Phase II of the RI at the site, including the rationale for the various field activities and the number of samples to be collected.

Samples will be analyzed by Accutest Laboratories using appropriate analytical methods for the isolation, detection, and quantification of specific target compounds and analytes. The applicable analytical methods (e.g., EPA SW-846 or equivalent) are referenced in the FSP and QAPP.

4.1 Utility Clearance and Site Reconnaissance

The initial site reconnaissance and characterization will be performed in accordance with Kleinfelder's standard operating procedure (SOP) No.1.0. The site reconnaissance and characterization will include site and utilities identification, and a topographic survey, including easements, site surface features, and rights-of-way.

4.2 Geologic Investigation

The soil investigation includes an evaluation of surface and subsurface soils with regard to the nature and extent of COPCs. On-site random grid sample locations are shown on Figures 3, 4 and 5. Field sample locations are subject to field verification, and may be adjusted due to utilities, accessibility, etc.

All soil data determined to be usable for risk assessment will also be used in the HHRA and ERA. The on-site Phase II investigation includes the evaluation of soil and groundwater from the surface to the shallow aquifer, at a depth of approximately 12 feet bgs.

4.2.1 On-Site Surface Soil Sampling

Surface soils refer to those soils from the ground surface to 0.5 feet bgs. To characterize soil at all locations (including planned sample locations presently below concrete or asphalt), and to ensure samples may be used to characterize future on-site risks assuming present ground cover will change, underlying soil will be accessed through 6-inch-diameter core holes, where necessary, to access soils beneath concrete or asphalt.

Surface soil will be collected with either a (1) drive sampler device lined with acetate sleeves using Geoprobe equipment or (2) hand sampling device, such as a soil hand auger or manual drive sampler.

Soil samples for nature and extent of COPCs will be collected from depths determined in the field, based on lithologic characteristics and field-screening techniques. In some AOCs, nature and extent will be evaluated by both grid and judgmental boring locations.

4.2.2 On-Site Random Grid Surface Soil Samples

The surface soil sampling interval will be 0.0 to 0.5 foot bgs. Samples will be field-screened with a photoionization detector (PID).

On-site random grid surface soil samples will be obtained at AOC-1, AOC-2, and AOC-4, properly stored, and subsequently analyzed at a fixed laboratory.

4.2.3 On-Site Random Grid Subsurface Soil Sampling

Subsurface soils refer to those soils from depths greater than 0.5 feet bgs. Subsurface soil samples will be collected with a drive sampler lined with acetate sleeves using Geoprobe equipment.

Subsurface soil samples will undergo the same sample preparation procedures outlined for surface soil samples.

Lithologic core samples will be collected to evaluate surface and subsurface soil conditions as well as profile the unsaturated zone.

Samples will be field-screened with selected samples submitted to the fixed laboratory for analysis of COPCs as noted in Table 3.

4.3 On-Site Groundwater Sampling

During Phase II, seven locations will be selected for installation of permanent monitor wells within AOC-1. These wells will be installed immediately following soil sample collection, and properly developed.

Post-development groundwater samples collected from permanent monitoring wells will not be filtered when analyzed for VOCs and SVOCs. Groundwater collected for metals analysis will be split into filtered and unfiltered samples to permit identification of ratios of dissolved and suspended metal concentrations. Use of these ratios for site management or risk assessment purposes will be subject to prior review and approval of EPA. Groundwater will be analyzed for COPCs as indicated in Table 3.

Depending on the preliminary COPCs present and the magnitude of concentrations detected in the shallowest aquifer, additional investigation to the next deeper aquifer (for vertical nature and extent) may or may not be indicated. Specifically, the detection of naturally occurring metals in the shallowest aquifer is to be expected. Therefore further assessment of the next deeper aquifer may not be indicated based on comparison to background concentrations and the presence of significant concentrations relative to appropriate screening levels (based on unit classification) are detected in permanent monitoring wells.

Further assessment of groundwater contaminants may require a second mobilization during Phase II. Installation of monitor wells to a deeper aquifer would also take place during a subsequent mobilization.

If the shallow aquifer is impacted by site-related COPCs, the underlying water-bearing zones (WBZs) may need evaluation to determine the nature and extent of COPCs if (1) hydrogeological connections are suspected and (2) the contaminant fate and transport characteristics indicate a potential for downward migration. The investigation and sampling needs for the deeper WBZs will be discussed with EPA after evaluation of the Phase II shallow aquifer data.

4.4 Off-Site Sampling

Off-site field activities will include the following:

- Obtaining access agreements;
- Sampling sediment in the wetlands and bay adjacent to the site;
- Sampling soil in residential areas; and
- Sampling at background locations.

Each off-site sampling activity is discussed in the following sections. The sampling intervals and analytical suites at each off-site sampling location are summarized in Table 3.

4.4.1 Background Sampling

The preliminary COPCs at the site are inorganic and organic contaminants, which may be both (1) naturally occurring in geologic formations and (2) anthropogenic (man-made) contaminants resulting from the site and from adjacent facilities.

Background sampling has three goals, including providing data for (1) comparison of COPCs in surficial soils; (2) establishing attribution, via establishing either the absence or low-level (naturally occurring) concentrations of indicator or signature inorganic constituents, which may have been released from the site; and (3) establishing site-specific background concentrations for application to both the off-site and on-site soil investigation.

To assist identification of background sampling locations with a minimum likelihood of impact from former operations at the site and from surrounding industry, the Corpus Christi Wind Rose from January 1984 through December 31, 1992 is provided as Figure 8. Review of the wind rose data indicate the predominant wind direction at the site is from the southeast. As a result, background sampling locations to the southwest and northeast of the site will be preferentially selected.

Provided as Figure 9, is a wetland distribution map from the National Wetland Inventory of the site. Review of the figure shows the wetlands immediately to the east of the refinery are depicted as palustrine, emergent, persistent, seasonally flooded and excavated. Due to the manmade influence on this habitat, background sampling will not include this habitat.

The adjoining wetlands are classified under two habitats: 1) as estuarine, intertidal, emergent, persistent and irregularly flooded and 2) estuarine, intertidal, unconsolidated shore and regularly flooded. Background wetland sediment sampling will be in these two habitats.

AOC-5, the intracoastal way Bay, is a different aquatic environment from the wetland areas adjoining the site. As such, background concentrations of COPCs may be different in the wetland sediments compared to the intracoastal sediments. Background sample data from the intracoastal will be evaluated separately from the wetland background sample data.

During Phase I, four background locations were selected for each media of concern. During Phase II, additional locations will be sampled (Figure 10).

To meet these goals, six surface soil, six subsurface soil, six groundwater, six sediment wetland, six sediment intercoastal and six surface water background samples, as noted in Table 3 and shown on Figure 10, will be collected from areas identified as unlikely to be impacted by site operations. The areas were selected based on similar soil, sediment, and surface water types to AOC soil, sediment, and surface water.

At each of the locations, a sample will be collected and analyzed for the preliminary COPCs noted in Table 3.

4.4.2 Off-Site Sediment and Surface Water Sampling

The RI will include an investigation of sediment and surface water in adjacent wetlands (AOC-3) and in the intracoastal waterway (AOC-5). Wetland sediment/soil sampling locations will be identified using random start grid locations identified using VSP. The basis of decision for the proposed number of additional surface water samples in AOC-3 and AOC-5 is presented in Table 2.

The sediment samples from the intracoastal waterway will be random start grid locations to determine if there are COPCs associated with the current and historic barge dock facilities and the culvert draining into the intracoastal waterway.

At each sampling point, a conscious effort will be made to sample surface water without disturbing sediment (and in sequence with surface water collected prior to sediment collection). The surface water samples will be collected using a coliwasa, long-handled dipper, or submerged sample jar. All surface water samples collected for VOC analysis will be placed in sample containers with zero headspace. No stratification of the dissolved phase surface water is expected, based on the preliminary class of COPCs and the depths of the ponds. Therefore sampling from the most accessible surface meets the DQOs for the vertical boundaries of the on-site surface waters.

For Phase II at least five surface water samples will be split into filtered and unfiltered samples and analyzed as appropriate. Data from analysis of these split samples will be evaluated to identify ratios of dissolved to unfiltered concentrations. Use of these ratios for site management or risk assessment purposes will be subject to prior review and approval of EPA.

Sediment samples will be collected from the top 0.5 feet using a hand core sampler driven with a slide hammer, long-handled dipper, or other suitable sampling device as site-specific conditions warrant.

Sediments will be analyzed for preliminary COPCs as outlined in Table 3.

5.0 SAMPLE DESIGNATIONS

Each sample obtained in the field will be designated with a unique alphanumeric designation according to the following sample classifications.

5.1 Grid Sample Designation

Geoprobe surface and subsurface soil samples will be collected at grid nodes in AOC-1, AOC-2 and AOC-4. Random sediment samples will be obtained from AOC-3 and AOC-5. The grid sample designation will include three fields separated by dashes. For example: G2-01S-4.0-4.5.

- The first field, "G2-01S" identifies the grid sample number within Phase II. The alpha character is the designation for grid sample (G). The following numerical characters are the distinct number for the random grid sample location. The following alpha characters indicate the sample is a soil sample (S). If the sample is a sediment sample the designation SD will be used.

- The second field, "4.0" represents the top of the sample interval measured in feet bgs.

- The third field, "4.5" represents the bottom of the sample interval measured in feet bgs.

5.2 Groundwater Sample Designation

Groundwater sample designations will include separate nomenclature for samples collected from temporary monitoring wells and permanent monitoring wells.

Permanent monitor well (MW) groundwater sample designations will include two fields separated by a dash. For example: MW01-05.

- The two alpha characters in the first field, "MW01" identify the sample as having been collected from a permanent monitoring well and "01" identifies the AOC.

- The second field, "05," represents the numerical designation for the permanent monitor well number.

If necessary to sample deeper aquifers during Phase II operations, an additional field will be added to the sample designations to show which aquifer is being assessed.

5.3 Surface Water Sample Designation

Surface water samples will be collected from wetlands and the intracoastal waterway. The surface water sample designation will include two fields separated by a dash. For example: SW-01. The two alpha characters in the first field, "SW" identify the sample as a surface water (SW) sample. The second field, "01" represents the numerical designation of the surface water sample.

5.4 Background Soil Sample Designation

Field background samples will be identified by "BG" followed by a sequential number. The background sample designation includes three fields separated by a dash. For example: BG-01S-0.0-0.5.

- The first field, "BG" identifies the sample as a background (BG) sample followed by "01" which represents the numerical designation of the sample. The following alpha characters indicate the sample is a soil sample (S). If the sample is a sediment sample the designation SD will be used.

- The second field, "0.0" represents the top of the sample interval measured in feet bgs.

- The third field, "0.5" represents the bottom of the sample interval measured in feet bgs.

5.5 Background Groundwater Sample Designation

Groundwater background samples will be collected from temporary monitor wells (TW). The background groundwater samples designation will include two fields separated by a dash. For example: TWBG-10.

- The alpha characters in the first field, "TWBG" identify the sample as having been collected from a temporary monitoring well and "BG" identifies the sample as a background sample.

- The second field, "10," represents the numerical designation for the temporary monitor well.

5.6 Background Surface Water Sample Designation

Background surface water samples will be collected from wetlands. The background surface water designation will include two fields separated by a dash. For example: BG-20SW. The alpha characters in the first field, "BG" identify the sample as a background sample. The numeric characters in the second field, "20" represent the numerical designation for the sample, followed by the alpha characters "SW", indicating the sample as a surface water sample.

5.7 Field Duplicate Sample Designation

Field duplicate samples will be identified by adding a "D" to the end of the sample designations described above. For example, TW01-05D or MW01-05D and J-03S-0.0-0.5D.

5.8 Matrix Spike/Matrix Spike Duplicate (MS/MSD) Sample Designation (for organic analyses)

Matrix Spike (MS) and Matrix Spike Duplicate (MSD) organic samples will be identified by adding an "MSD" to the end of the sample designations described above, for example: MW01-05MSD and J-03S-0.0-0.5MSD.

5.9 Matrix Spike/Matrix Duplicate (MS/MD) Sample Designation (for inorganic analyses)

MS and Matrix Duplicate (MD) inorganic samples will be identified by adding an "MD" to the end of the sample designations described above. For example: MW01-05MD and J-03S-0.0-0.5MD.

5.10 Trip and Equipment Blank Sample Designation

Trip and equipment blank samples will be identified sequentially beginning with TB-1 and EB-1, respectively.

6.0 SAMPLING EQUIPMENT AND PROCEDURES

This section is described in detail in the approved FSP dated August 24, 2008.

7.0 SCHEDULE

The following brief project schedule is planned:

- Phase II Field Investigations: July 2009 through August 2009
- Data Analysis: Phase II July 2009 through October 2009
- Draft Preliminary Site Characterization Summary Report: November 2009
- Draft Baseline Human Health Risk Assessment: May 2010
- Draft Screening Level Ecological Risk Assessment: May 2010
- Draft Remedial Investigation Report: May 2010
- Draft Feasibility Study Report: November 2010

A detailed schedule of all activities is available in the RI/FS Work Plan.

FIGURES

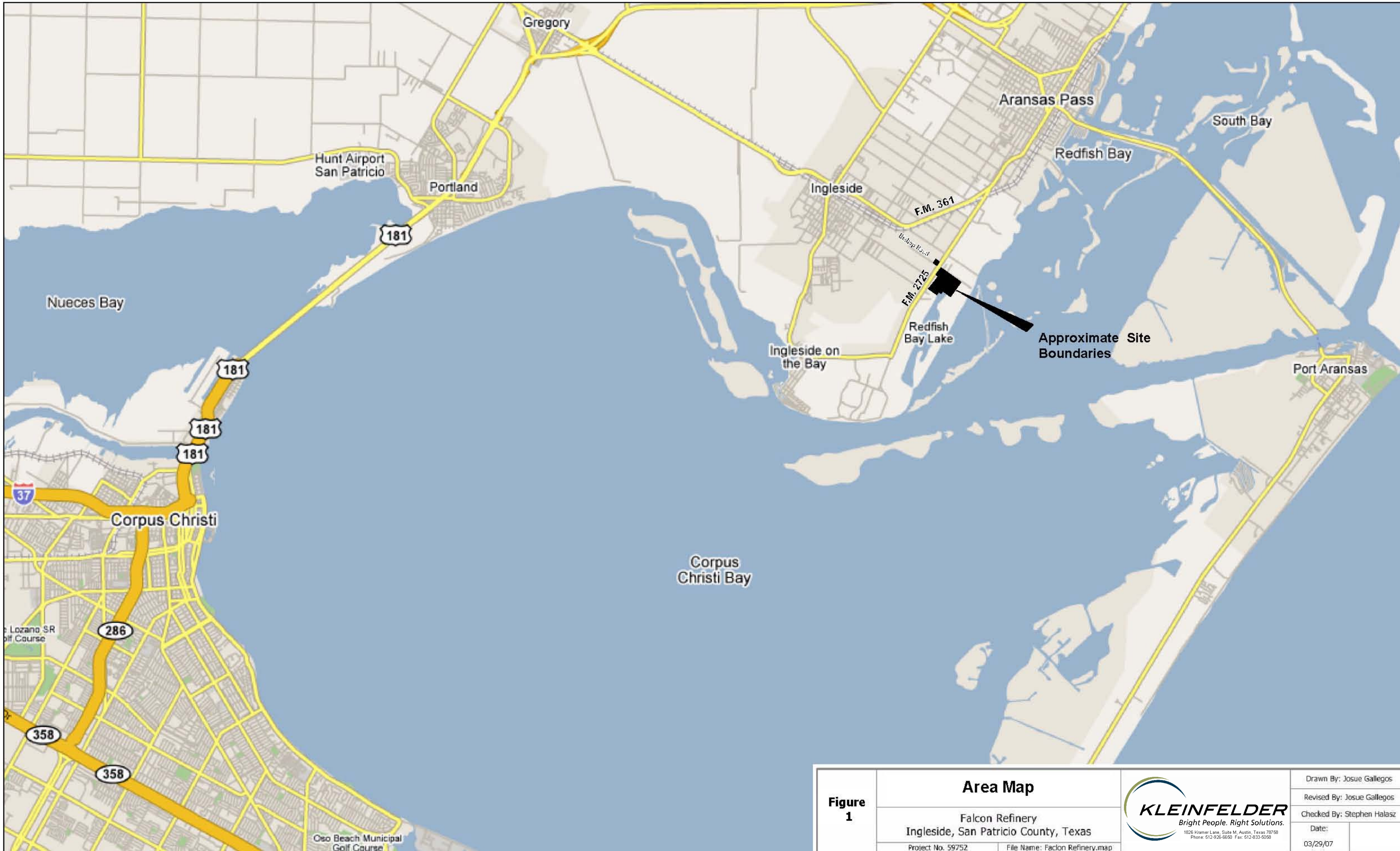
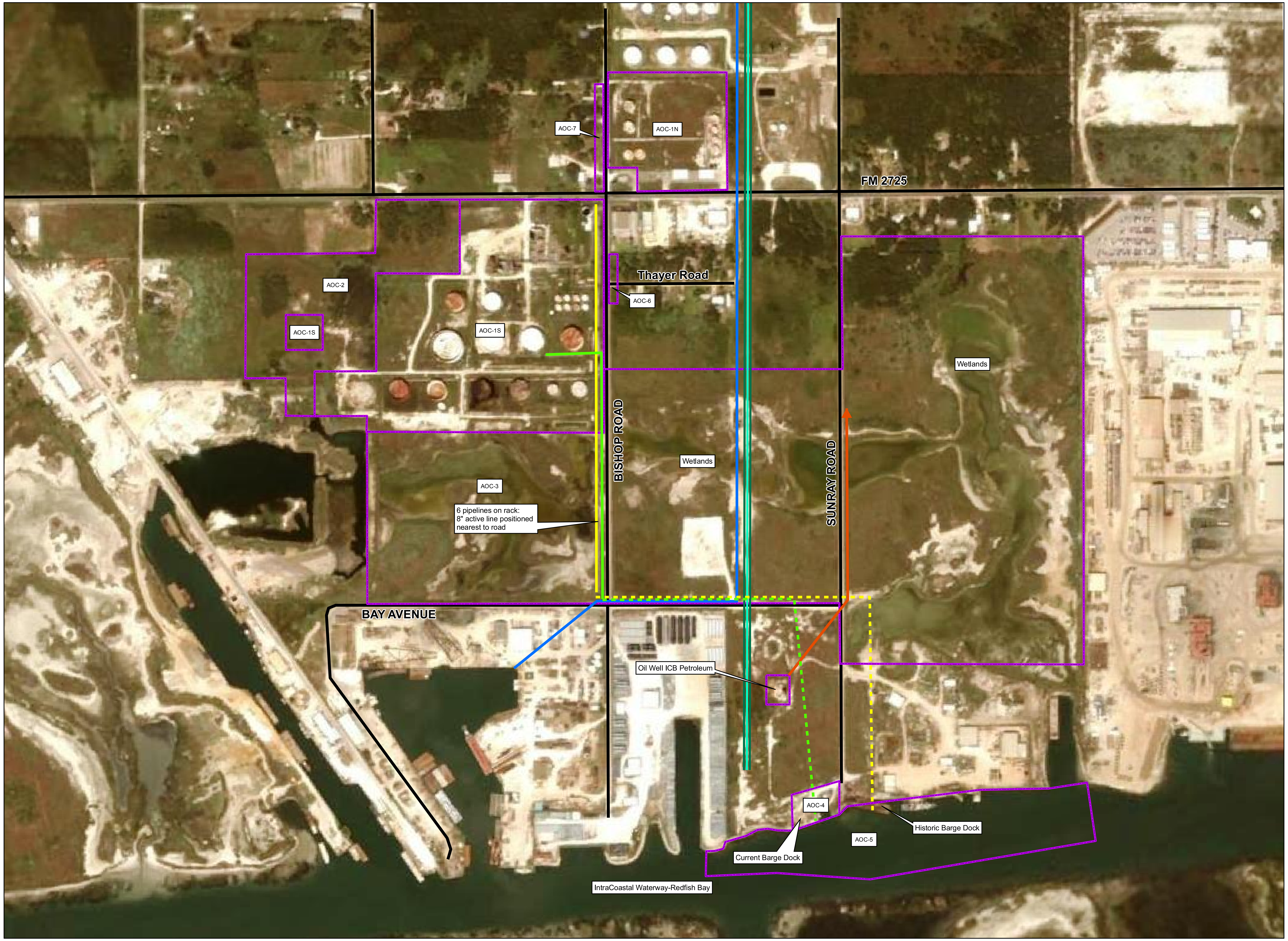


Figure 1	Area Map	KLEINFELDER Bright People. Right Solutions. 1826 Kramer Lane, Suite M, Austin, Texas 78758 Phone: 512-926-6650 Fax: 512-833-5058	Drawn By: Josue Gallegos
	Falcon Refinery Ingleside, San Patricio County, Texas		Revised By: Josue Gallegos
	Project No. 59752 / File Name: Faclon Refinery.map		Checked By: Stephen Halasz
			Date: 03/29/07



Legend

Active NORCO Pipeline
- Above Ground
- Underground

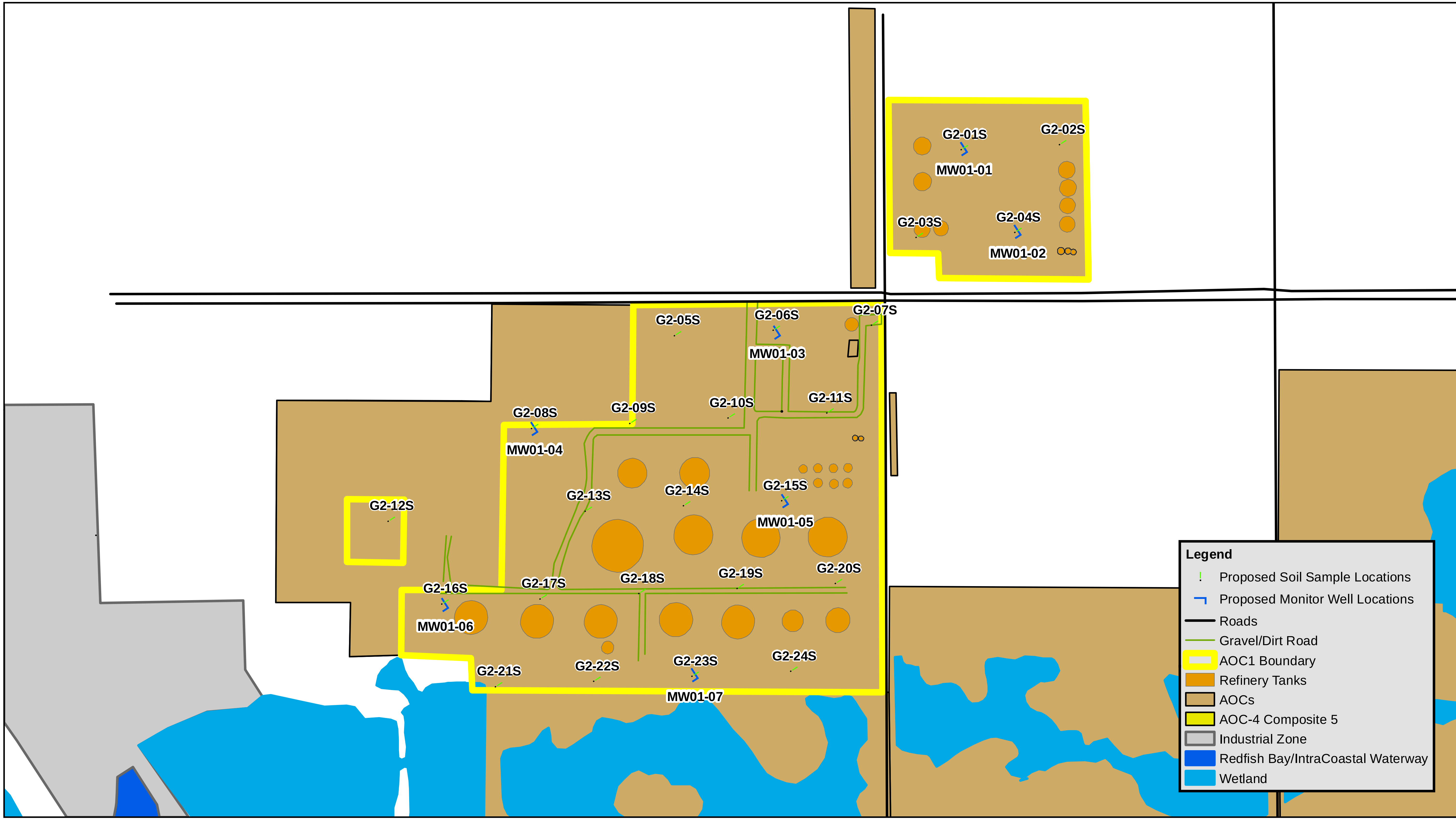
Abandoned NORCO Pipeline
- Above Ground
- Underground

Outside Operations
- Gulf South Pipeline
- Boss Pipeline
- Gathering Line 2'
- Plains Marketing Pipeline

- Area of Concern (AOC)
- Roads

0 150 300 600 Feet

Figure 2	AREA OF CONCERN MAP		KLEINFELDER	Drawn By: MAEA
	Falcon Refinery Ingleside, San Patricio County, Texas		Bright People. Right Solutions.	Revised By: WITT
	Project No. 59752	Filename: Falcon Refinery w/ Photo. mxd	1826 Kramer Lane, Suite M, Austin, Texas 78758 Phone: 512-926-6650 Fax: 512-833-5058	Checked By:
				Date: 4/1/2009



0 500 1,000
Feet

DATE DRAWN: 4/1/09	DATE REVISED: 5/21/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC1
Proposed Sample Locations

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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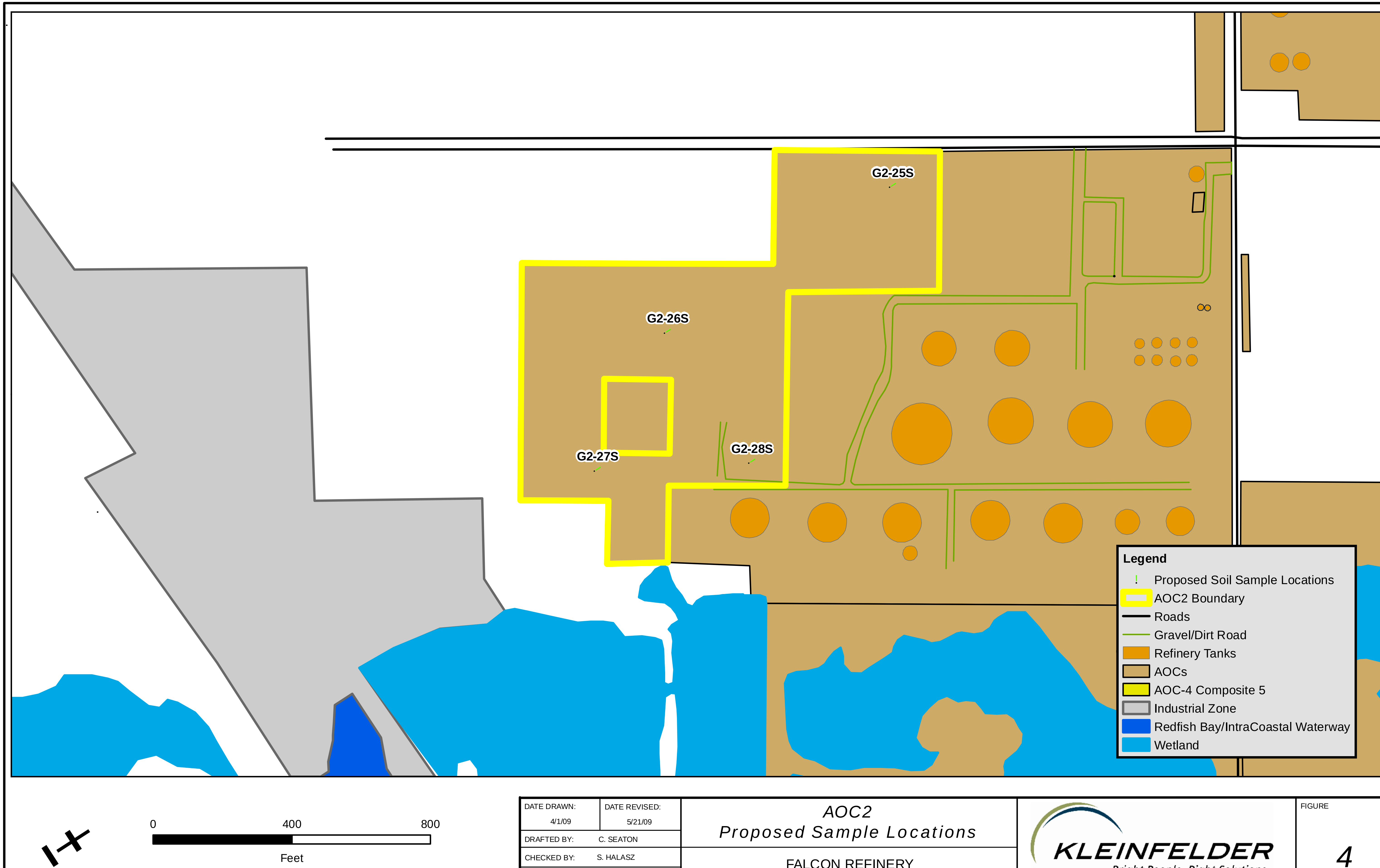
FIGURE
3



DATE DRAWN: 4/1/09	DATE REVISED: 5/21/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC2
Proposed Sample Locations

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 | FILE NAME: Falcon Refinery Base Map

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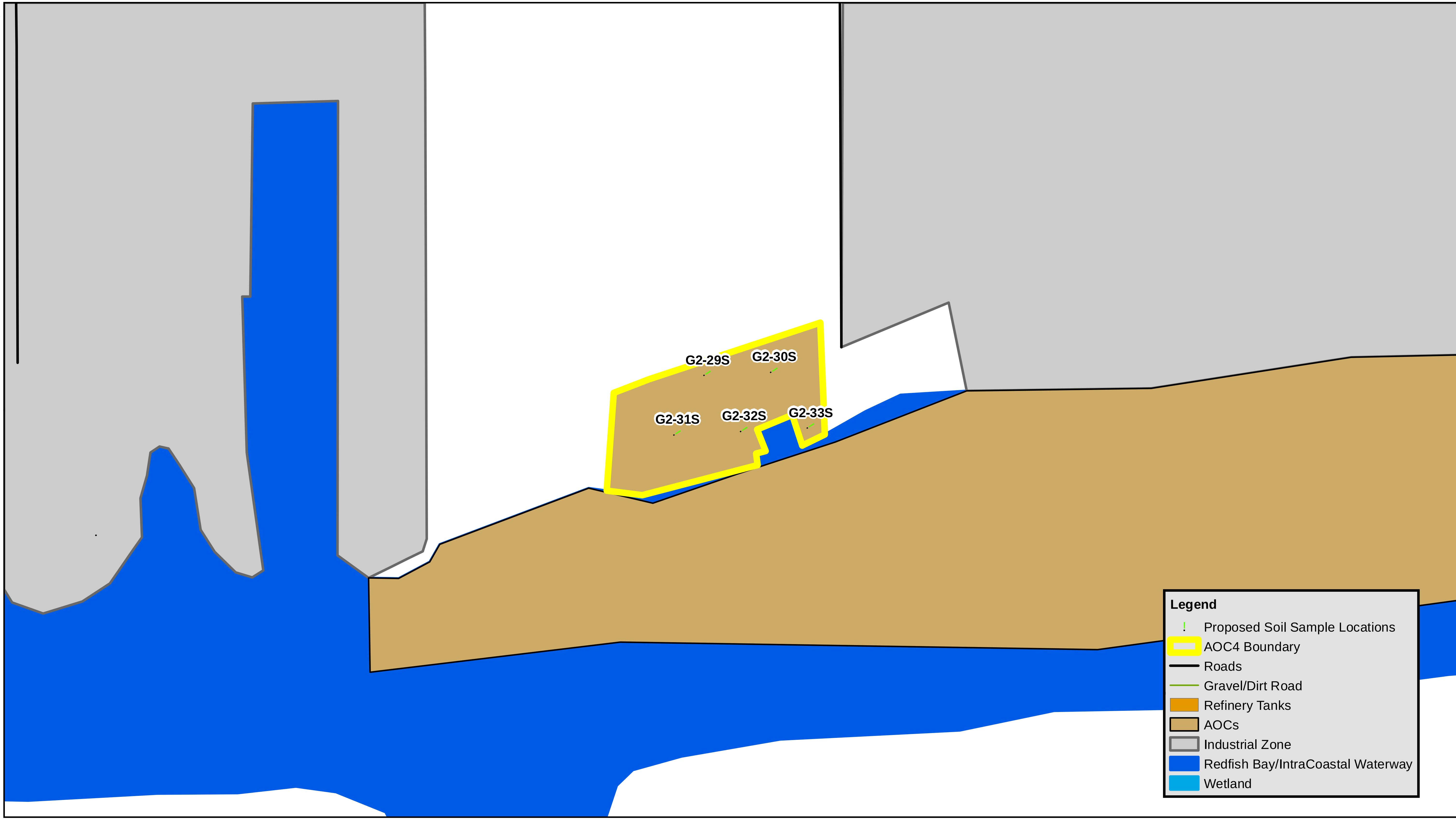
FIGURE
4



DATE DRAWN: 4/1/09	DATE REVISED: 5/21/09
DRAFTED BY: C. SEATON	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC4
Proposed Sample Locations

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 | FILE NAME: Falcon Refinery Base Map

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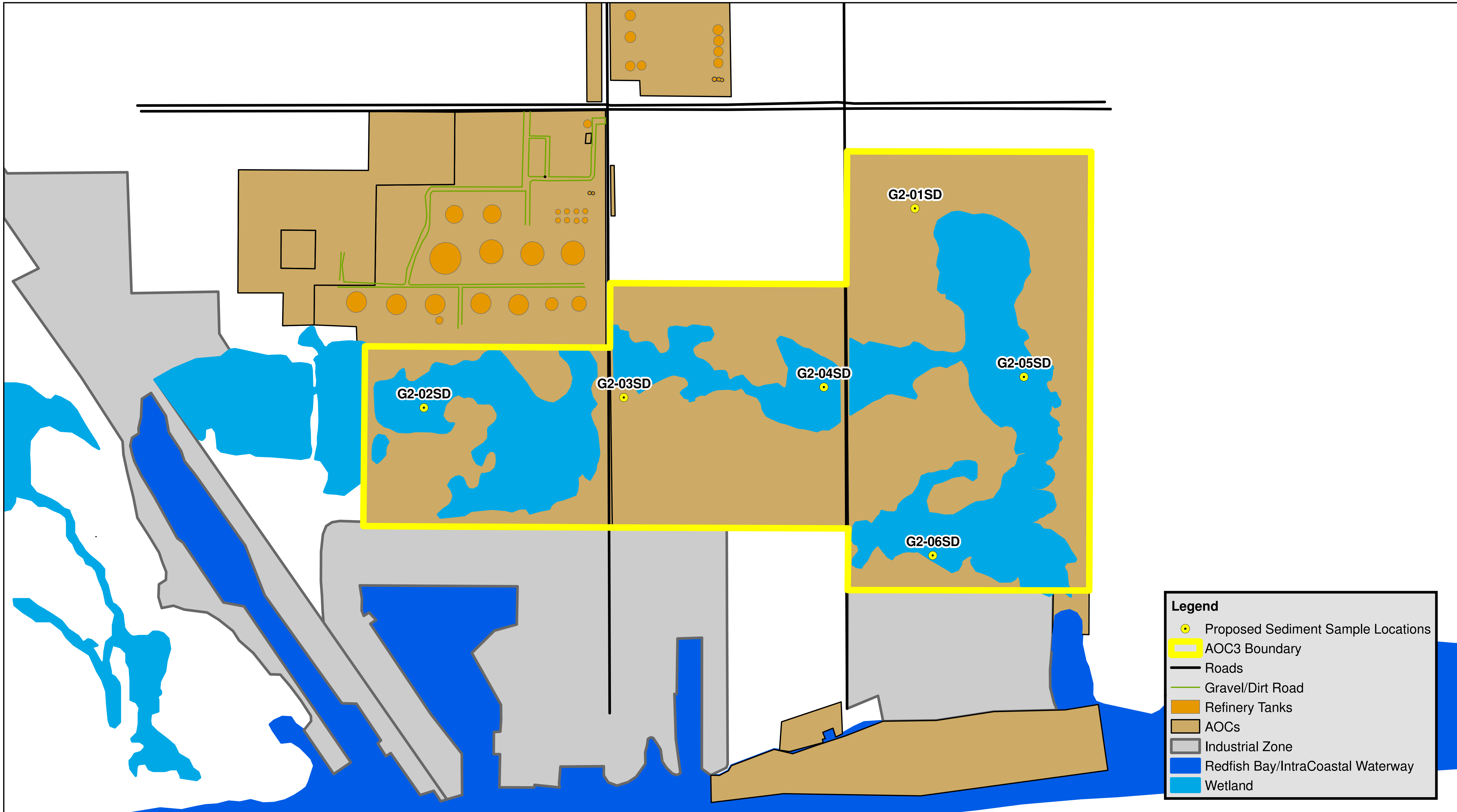
FIGURE
5



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Feet

DATE DRAWN: 4/1/09	DATE REVISED:
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC3

Proposed Sample Locations

FALCON REFINERY

INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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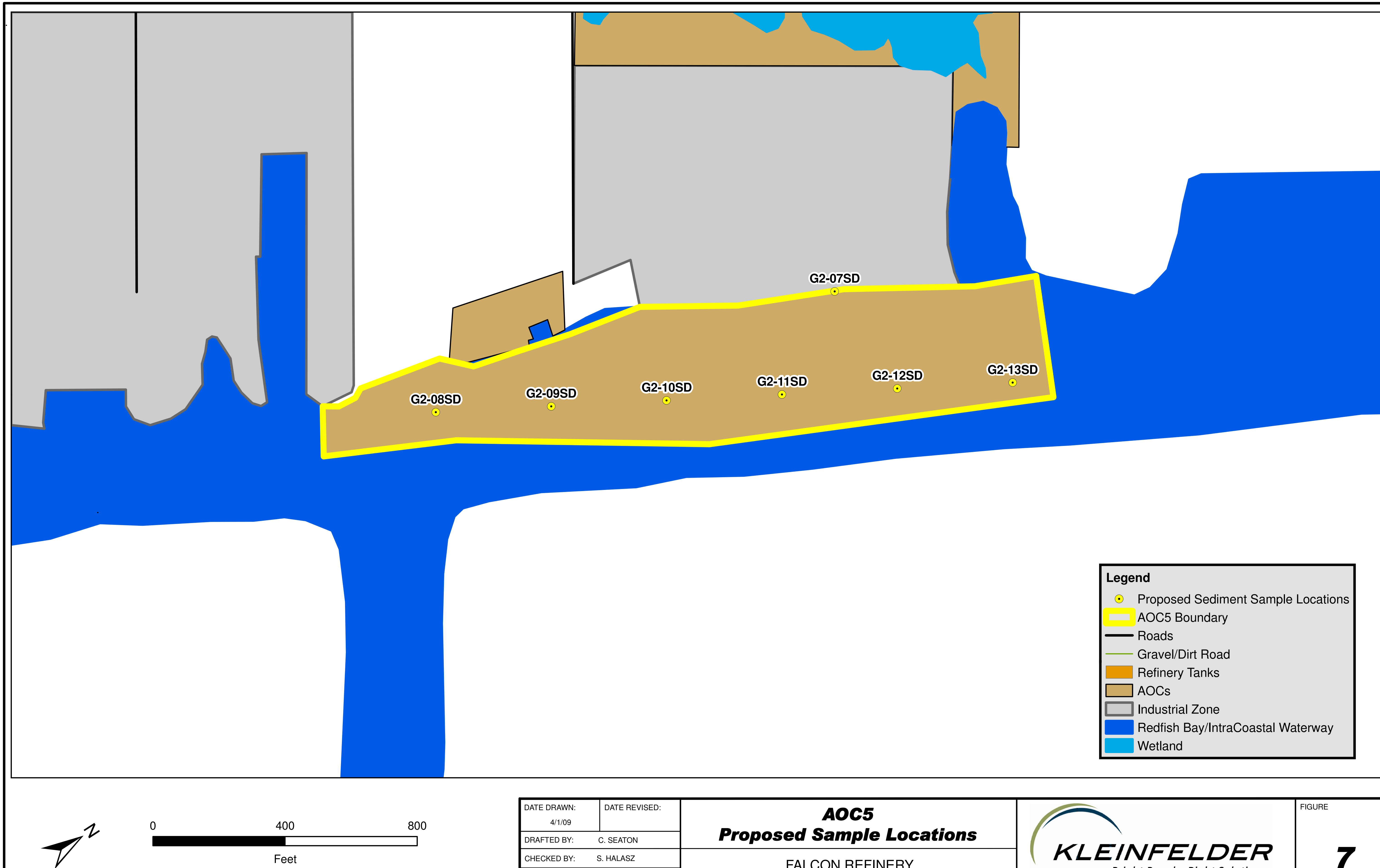
FIGURE

6



DATE DRAWN: 4/1/09	DATE REVISED:
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC5
Proposed Sample Locations

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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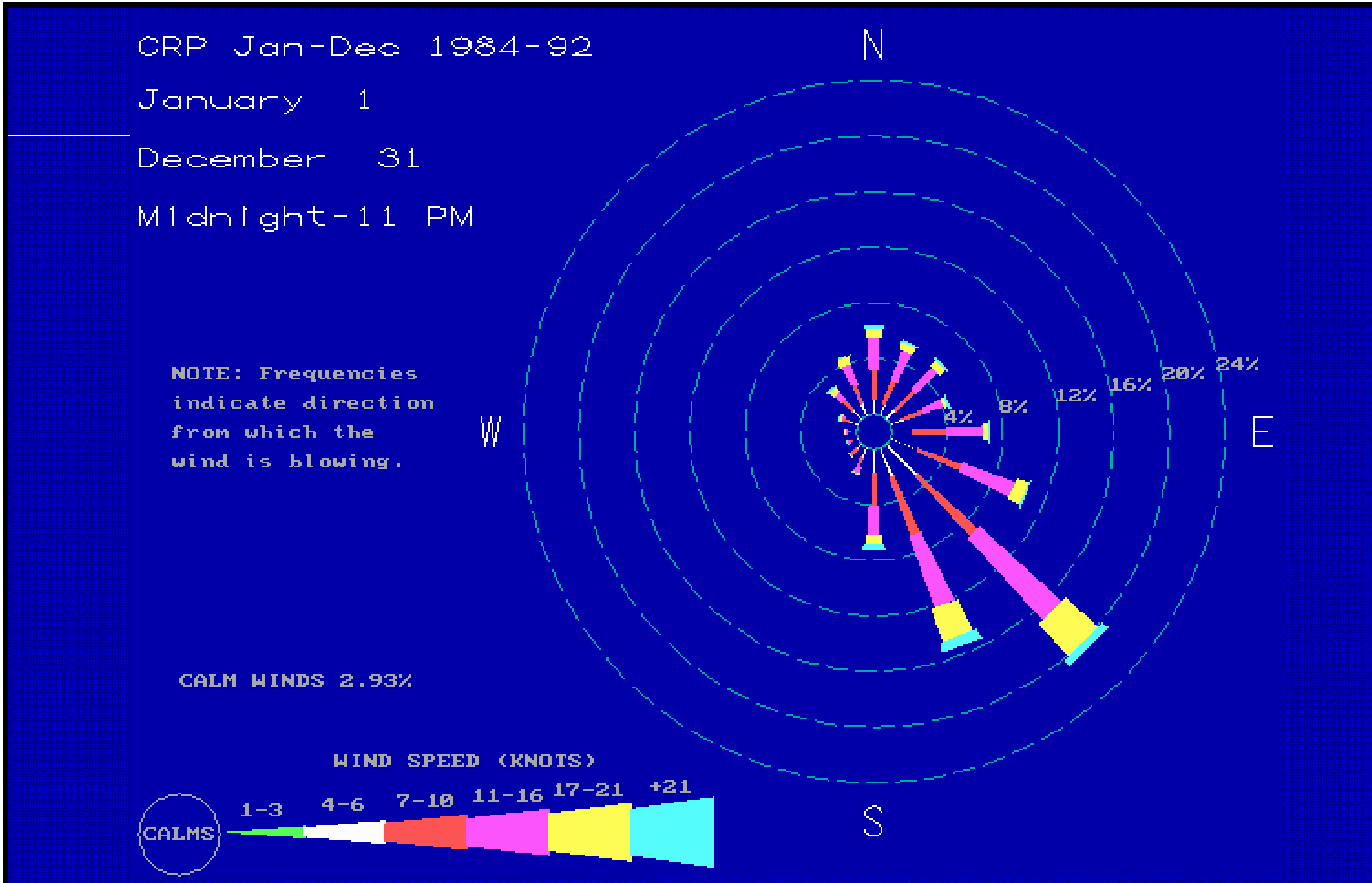
FIGURE
7



PROJECT NO.	59752
DRAWN:	May 2009
DRAWN BY:	C. Seaton
CHECKED BY:	S. Halasz
FILE NAME:	G:/Environ/Falcon/FSP/Figures

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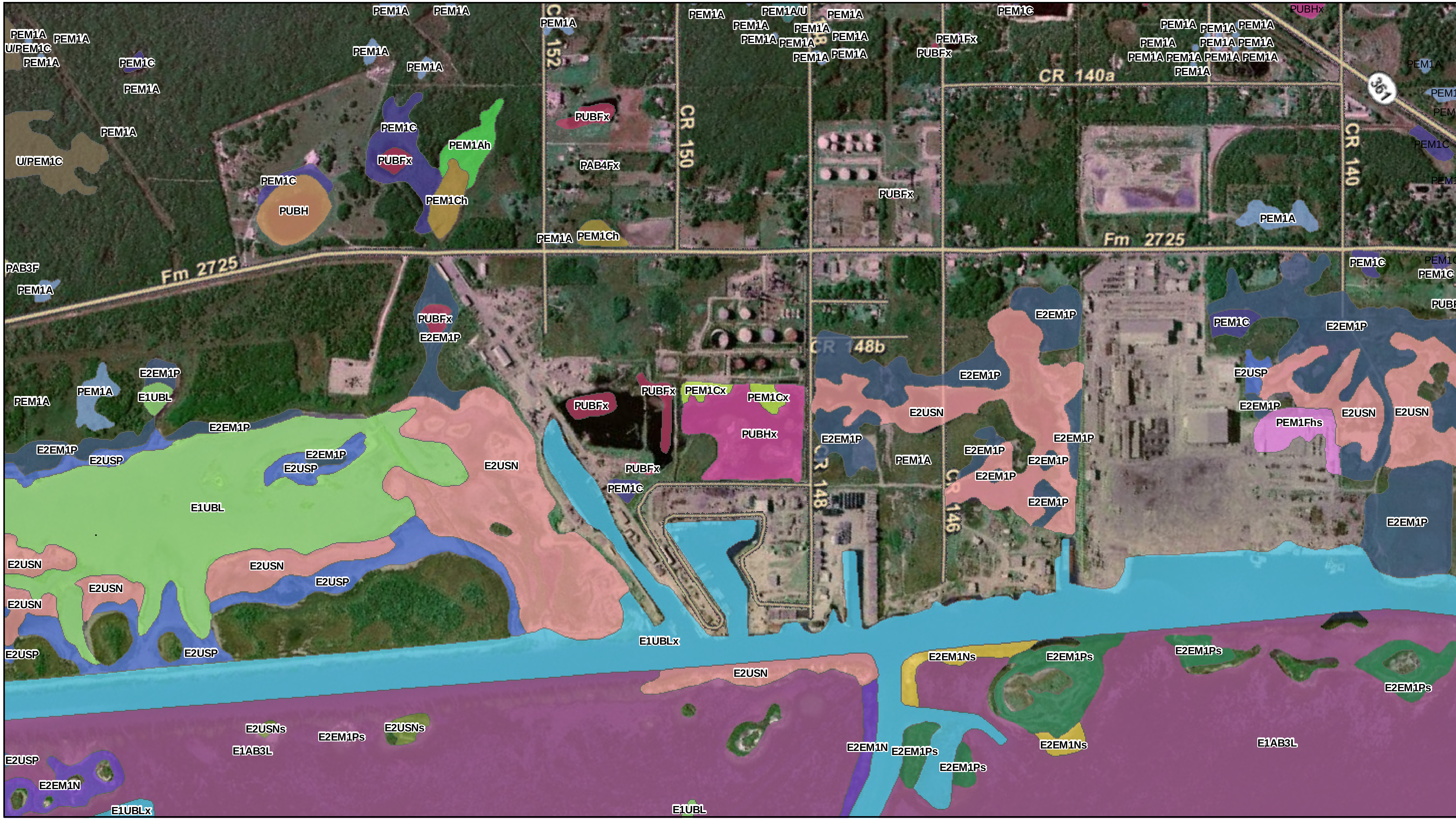
CORPUS CHRISTI WIND ROSE

Falcon Refinery
Ingleside, San Patricio County, Texas

FIGURE
8



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Feet

DATE DRAWN: 05/09	DATE REVISED:
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

National Wetland Inventory Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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FIGURE
9

DATE DRAWN: 04/09	DATE REVISED: 05/09	**Background Sampling Location Map**	FIGURE
DRAFTED BY: C. SEATON		FALCON REFINERY INGLESIDE, SAN PATRICIO COUNTY, TEXAS	**10**
CHECKED BY: S. HALASZ			
APPROVED BY:		PROJ NO. 59752	FILE NAME: Falcon Refinery Base Map

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TABLES

1. AREAS OF CONCERN
2. SUMMARY TABLE OF CALCULATED MINIMUM SAMPLE QUANTITIES
3. FIELD SAMPLING DESIGN

TABLE 1
AREAS OF CONCERN
FALCON REFINERY SUPERFUND SITE
INGLESIDE, TEXAS

AOC	LOCATION		SURFACE WATER SAMPLE NUMBER	SAMPLE LOCATION NUMBER	MONITOR WELL/GROUNDWATER LOCATONS	COPCs
1N	North section of the Refinery complex, on the northeast side of the FM 2725/Bishop Rd. intersection.	Surface Soil Subsurface Soil Groundwater		G2-01S - G2-04S	MW01-01 - MW01-02	Metals VOCs SVOCs PCBs Pesticides
1S	South section of the Refinery complex, on the southwest side of the FM 2725/Bishop Rd. intersection.	Surface Soil Subsurface Soil Groundwater		G2-05S - G2-24S	MW-03 - MW-07	Metals VOCs SVOCs PCBs Pesticides
2	On-site non-process areas, west of the south section of the Refinery complex.	Surface Soil Subsurface Soil		G2-25S - G2-28S		Metals VOCs SVOCs PCBs Pesticides
3	Wetlands	Surface Soil Subsurface Soil Sediment Surface Water	G2-01SW - G2-16SW	G2-01SD - G2-06SD		Metals VOCs SVOCs PCBs Pesticides
4	Current barge docking site	Surface Soil Subsurface Soil		G2-29S - G2-33S		Metals VOCs SVOCs PCBs Pesticides
5	Redfish Bay adjacent to current barge docking facility	Sediment Surface Water		G2-07SD - G2-13SD		Metals VOCs SVOCs PCBs Pesticides
6	Neighborhood **					
7	Neighborhood **					
BG	To be determined	Surface Soil Subsurface Soil Groundwater Sediment Surface Water	BG-15SW - BG20-SW	BG-09S - BG-14S BG-15SDW - BG-20SDW BG-21SDI - BG-26SDI	TWBG-09 - TWBG-14	Metals VOCs SVOCs

* Due to flucuations in surface water locations within wetlands, exact locations are not listed.
** May require sampling after Phase II addendum No. 1

AOC	Area of Concern
COPC	Contaminant of Potential Concern
VOC	Volatile Organic Compound
GW	groundwater
BKG	Background
SVOC	Semi-volatile Organic Compound
SD	Sediment
SW	Surface water

TABLE 2
SUMMARY OF CALCULATED MINIMUM SAMPLE QUANTITIES
FALCON REFINERY
INGLESIDE, TEXAS

AOC	Media	Quantity of Discrete Phase I Samples	Additional Sample Number Basis			Proposed Quantity of Additional Samples
			Human Health	Ecological	Best Professional Judgment	
AOC 1	Soil: Surface & Subsurface	41	14	None	Not Applicable	24
	Sediment	2	Not Applicable	Not Applicable	None	None
	Groundwater	20	7	Not Applicable	Not Applicable	7
AOC 2	Soil: Surface & Subsurface	Composite Samples	Not Applicable	Not Applicable	4	4
AOC 3	Soil: Surface & Subsurface	7	1	14	None	None
	Sediment	44	None	None	6	6
	Surface Water	7	16	5	Not Applicable	16
AOC 4	Soil: Surface & Subsurface	Composite Samples	Not Applicable	Not Applicable	5	5
AOC 5	Sediment	3	Not Applicable	Not Applicable	7	7
AOC 6	Soil: Surface & Subsurface	3	Not Applicable	Not Applicable	None	None
AOC 7	Soil: Surface & Subsurface	2	Not Applicable	Not Applicable	None	None

TABLE 3

SAMPLING AND DESIGN MATRIX
FALCON REFINERY SUPERFUND SITE
INGLESIDE, TEXAS

SAMPLING TYPE	AREA OF CONCERN NUMBER	INTERVAL (feet bgs)	ANALYSES: TCL VOC	TCL SVOC	TAL METALS	PCBs	Herbicides and Pesticides
ON-SITE JUDGMENTAL SURFACE AND SUBSURFACE SOIL SAMPLES (up to 42 locations)							
Geoprobe	1N	0 to 0.5	2	2	2	0	0
		0.5 to 5.0	2	2	2	0	0
	1S	0 to 0.5	12	12	12	0	0
		0.5 to 5.0	12	12	12	0	0
TOTAL FOR ON-SITE AOC-1 RANDOM GRID SAMPLES			**28**	**28**	**28**	**0**	**0**
QC FOR JUDGMENTAL SAMPLES							
QC MS/MSD* {1/20 organics}		Various	2	2	N/A	N/A	0
QC MS/MD* {1/20 organics}		Various	N/A	N/A	N/A	0	N/A
QC trip blank		1	N/A	N/A	N/A	N/A	N/A
QC field duplicate {1/10}		Various	3	3	3	0	0
QC EQUIPMENT RINSATE		N/A	2	2	2	0	0
		TOTAL QC SAMPLES	**7**	**7**	**5**	**0**	**0**
Geoprobe	2	0 to 0.5	4	4	4	0	0
		0.5 to 5.0	4	4	4	0	0
	4	0 to 0.5	5	5	5	0	0
		0.5 to 5.0	5	5	5	0	0
TOTAL FOR ON-SITE AOC-2 and AOC-4 RANDOM GRID SAMPLES			**18**	**18**	**18**	**0**	**0**
QC FOR GRID SOIL SAMPLES							
QC MS/MSD* {1/20 organics}		Various	1	1	N/A	N/A	0
QC MS/MD* {1/20 organics}		Various	1	1	N/A	N/A	N/A
QC trip blank		1	1	1	N/A	0	N/A
QC field duplicate {1/10}		Various	2	2	2	0	0
QC equipment rinsate		N/A	1	1	1	0	0
		TOTAL GRID QC SAMPLES	**6**	**6**	**3**	**0**	**0**

TABLE 3

SAMPLING AND DESIGN MATRIX
FALCON REFINERY SUPERFUND SITE
INGLESIDE, TEXAS

SAMPLING TYPE	AREA OF CONCERN NUMBER	INTERVAL (feet bgs)	ANALYSES: TCL VOC	TCL SVOC	TAL METALS	PCBs	Herbicides and Pesticides
OFF-SITE JUDGMENTAL SURFACE AND SUBSURFACE SAMPLES							
Geoprobe	3	0 to 0.5	0	0	0	0	0
		0.5 to 5.0	0	0	0	0	0
	5	0 to 0.5	0	0	0	0	0
	6	0 to 0.5	0	0	0	0	0
		0.5 to 5.0	0	0	0	0	0
	7	0 to 0.5	0	0	0	0	0
		0.5 to 5.0	0	0	0	0	0
TOTAL FOR ON-SITE JUDGMENTAL SAMPLES			**0**	**0**	**0**	**0**	**0**

QC FOR OFF-SITE JUDGMENTAL SAMPLES AT 13 LOCATIONS						
QC MS/MSD* {1/20 organics}	Various	0	0	N/A	N/A	0
QC MS/MD* {1/20 organics}	Various	N/A	N/A	N/A	0	N/A
QC trip blank {1/cooler for aqueous VOCs}	N/A	N/A	N/A	N/A	N/A	N/A
QC field duplicate {1/10}	Various	0	0	0	0	0
QC EQUIPMENT RINSATE	N/A	0	0	0	0	0
TOTAL QC SAMPLES		**0**	**0**	**0**	**0**	**0**

OFF-SITE RANDOM GRID SURFACE AND SUBSURFACE SOIL SAMPLES (up to 6 locations)							
Geoprobe	3	0 to 0.5	6	6	6	0	0
TOTAL FOR GRID SAMPLES			**6**	**6**	**6**	**0**	**0**

QC FOR GRID SOIL SAMPLES						
QC MS/MSD* {1/20 organics}	Various	1	1	N/A	N/A	0
QC MS/MD* {1/20 organics}	Various	N/A	N/A	N/A	N/A	N/A
QC trip blank {1/cooler for aqueous VOCs}	N/A	N/A	N/A	N/A	0	N/A
QC field duplicate {1/10}	Various	1	1	1	0	0
QC equipment rinsate	N/A	1	1	1	0	0
TOTAL GRID QC SAMPLES		**3**	**3**	**2**	**0**	**0**

TABLE 3

SAMPLING AND DESIGN MATRIX
FALCON REFINERY SUPERFUND SITE
INGLESIDE, TEXAS

SAMPLING TYPE	AREA OF CONCERN NUMBER	INTERVAL (feet bgs)	ANALYSES				
			TCL VOC	TCL SVOC	TAL METALS	PCBs	Herbicides and Pesticides
GROUNDWATER SAMPLING (7 Monitor Wells)							
Bailer	1N	Shallow aquifer	1	1	1	0	0
	1S	Shallow aquifer	6	6	6	0	0
		TOTAL FOR GRID SAMPLES	**7**	**7**	**7**	**0**	**0**
QC FOR AQUEOUS SAMPLES Monitor Wells							
QC MS/MSD* {1/20 organics}		Various	1	1	N/A	N/A	0
QC MS/MD* {1/20 organics}		Various	N/A	N/A	N/A	0	N/A
QC trip blank {1/cooler for aqueous VOCs}		N/A	2	1	N/A	N/A	N/A
QC field duplicate {1/10}		Various	1	1	1	0	0
QC Equipment Rinsate		Various	1	1	1	0	0
		TOTAL QC SAMPLES	**5**	**4**	**2**	**0**	**0**
SURFACE WATER SAMPLING							
Grab	3	Surface	16	16	16	0	0
	Background	Surface	6	6	6	0	0
		TOTAL FOR GRID and BACKGROUND SW SAMPLES	**22**	**22**	**22**	**0**	**0**
QC FOR AQUEOUS SAMPLES (TEMPORARY WELLS)							
QC MS/MSD* {1/20 organics}		Various	2	2	N/A	N/A	1
QC MS/MD* {1/20 organics}		Various	N/A	N/A	N/A	0	N/A
QC trip blank {1/cooler for aqueous VOCs}		N/A	2	2	N/A	N/A	N/A
QC field duplicate {1/10}		Various	1	1	1	0	0
QC Equipment Rinsate		Various	1	1	1	0	0
		TOTAL QC SAMPLES	**6**	**6**	**2**	**0**	**1**

TABLE 3

SAMPLING AND DESIGN MATRIX
FALCON REFINERY SUPERFUND SITE
INGLESIDE, TEXAS

SAMPLING TYPE	AREA OF CONCERN NUMBER	INTERVAL (feet bgs)	ANALYSES: TCL VOC	TCL SVOC	TAL METALS	PCBs	Herbicides and Pesticides
BACKGROUND SAMPLES (JUDGMENTAL)							
Grab	Sediment	0-0.5	6	6	6	0	0
Geoprobe	Surface Soil	0-0.5	6	6	6	0	0
	Subsurface Soil	0.5-5.0	6	6	6	0	0
		TOTAL FOR GRID SAMPLES	**18**	**18**	**18**	**0**	**0**
QC FOR AQUEOUS SAMPLES (TEMPORARY WELLS)							
QC MS/MSD* {1/20 organics}		Various	2	2	N/A	N/A	0
QC MS/MD* {1/20 organics}		Various	N/A	N/A	N/A	0	N/A
QC trip blank {1/cooler for aqueous VOCs}		N/A	1	1	N/A	N/A	N/A
QC field duplicate {1/10}		Various	2	2	2	0	0
QC Equipment Rinsate		Various	1	1	1	0	0
		TOTAL QC SAMPLES	**6**	**6**	**3**	**0**	**0**
INVESTIGATION-DERIVED WASTE							
Hand sampling device	Site-wide	Drummed Waste	TO BE DETERMINED				
QC FOR INVESTIGATION-DERIVED WASTE							
QC MS/MSD* {1/20 organics}		Various	0	0	N/A	N/A	0
QC MS/MD* {1/20 organics}		Various	N/A	N/A	N/A	0	N/A
QC trip blank {1/cooler for aqueous VOCs}		N/A	0	N/A	N/A	N/A	N/A
QC field duplicate {1/10}		Various	0	0	0	0	0
QC Equipment Rinsate		Various	0	0	0	0	0
		TOTAL QC SAMPLES	**0**	**0**	**0**	**0**	**0**

* MS/MSD and MS/MDs: These samples do not increase the number of samples, but represent additional volume of sample for laboratory QA/QC.

AOC	Area of Concern	N/A	Not Applicable
bgs	Below Ground Surface	PCB	Polychlorinated Byphenyls
MD	Matrix Duplicate	QC	Quality Control
MS	Matrix Spike	SVOC	Semivolatile Organi
MSD	Matrix Spike Duplicate	VOC	Volatile Organic Compound

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APPENDIX A

PHASE 1 ANALYTICAL RESULTS FIGURES

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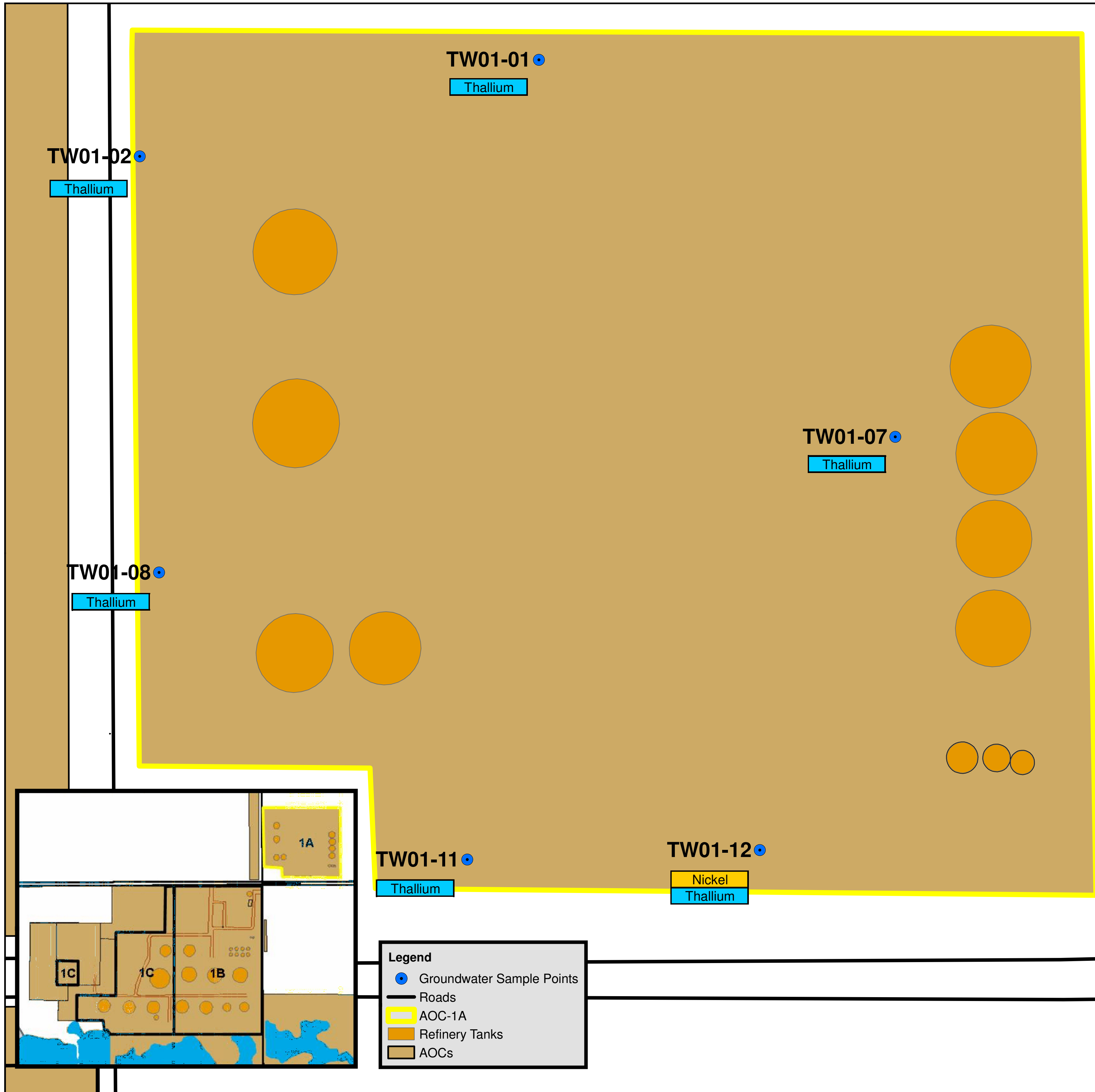

TW01-01 FR-015	
Aluminum	1630
Barium	54.3 B
Iron	1060
Manganese	139
Thallium	4.8 B
Vanadium	2.1 B
Zinc	14 B

TW01-02 FR-018	
Aluminum	372
Arsenic	2.8 B
Barium	18.6 B
Iron	578
Manganese	170
Thallium	5.1 B
Vanadium	1.2 B
Zinc	21.5

TW01-07 FR-032	
Aluminum	709
Barium	58 B
Iron	1540
Manganese	111
Thallium	5.1 B
Vanadium	2.5 B
Zinc	16.5 B

TW01-08 FR-024	
Aluminum	680
Arsenic	3.8 B
Barium	27.1 B
Iron	2150
Manganese	110
Thallium	6.2 B
Vanadium	1.5 B
Zinc	15.1 B

TW01-11 FR-003	
Aluminum	354
Arsenic	3.5 B
Barium	51.1 B
Iron	1720
Manganese	324
Thallium	6.7 B
Vanadium	1.9 B
Zinc	14.3 B

TW01-12 FR-006	
Aluminum	558
Barium	71.4 B
Chromium	7.9 B
Hex Chrom	0.005 B
Iron	1050
Manganese	146
Nickel	51.6
Thallium	4.8 B
Vanadium	1.1 B
Zinc	13.3 B

Notes:

1. Results are posted in µg/l
   Hex Chrom posted in mg/l

2. Qualifiers:

   B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds EPA Region 6 MSSL or MCL If Available

Exceeds Both EPA and TCEQ Limit

N

0 100 200

Feet

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON/G.WITT
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1A
Human Health
Metal Groundwater Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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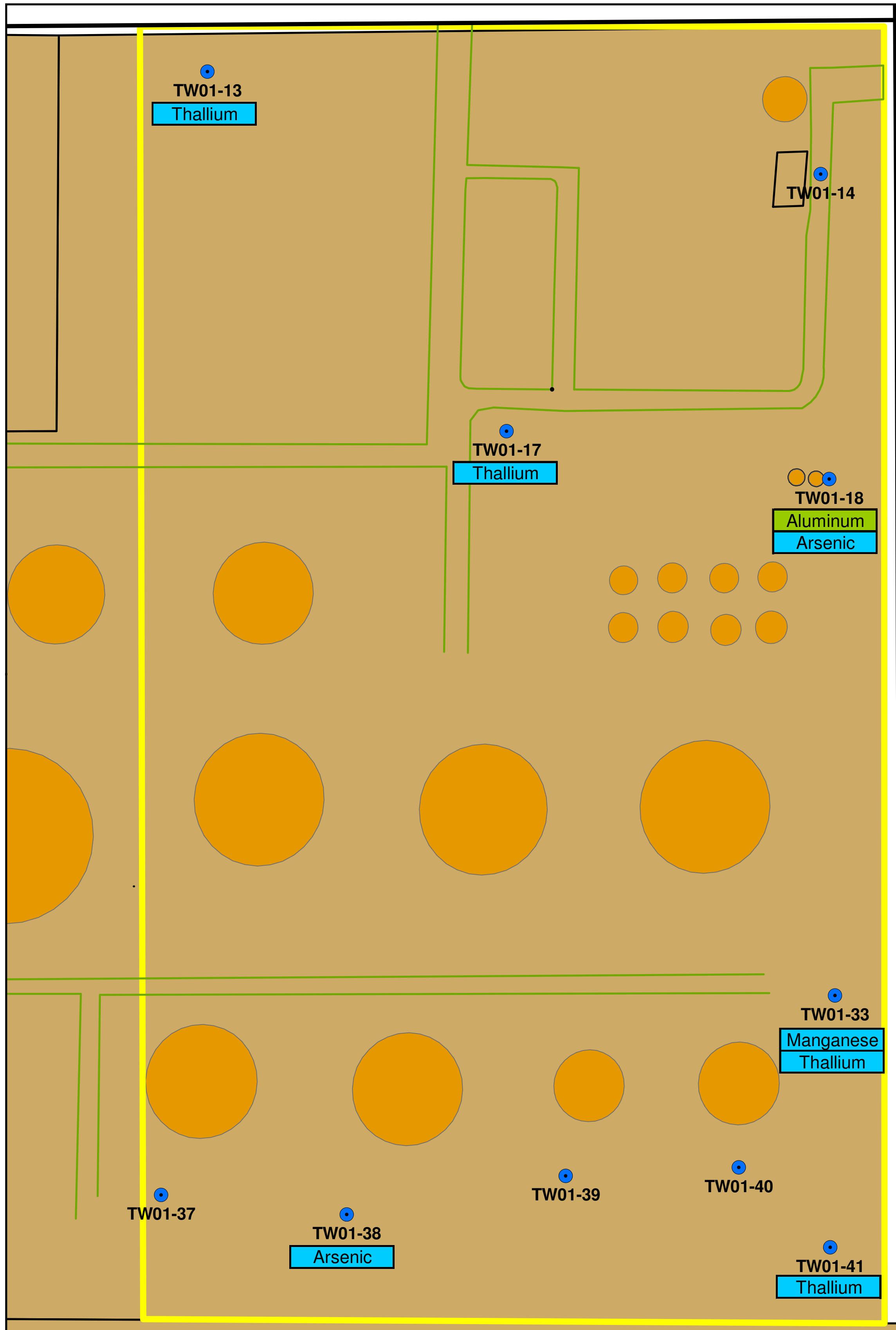
FIGURE
1A



TW01-13 FR-066	
Barium	238
Hex Chrom	0.059
Iron	115
Manganese	394
Thallium	3.5 B
Zinc	15.5 B

TW01-14 FR-063	
Aluminum	91.1 B
Arsenic	2.7 B
Barium	139 B
Iron	909
Manganese	276
Thallium	2.7 U
Vanadium	1.1 B
Zinc	21.6

TW01-17 FR-048A	
Arsenic	4.6
Barium	139 B
Iron	10150
Manganese	452.5
Selenium	2.35 J
Thallium	2.9 B
Vanadium	2.15 B
Zinc	16.65 B

TW01-18 FR-052	
Aluminum	4280
Arsenic	21.1
Barium	83.6 B
Chromium	4.8 B
Hex Chrom	0.023
Iron	3230
Lead	10
Manganese	118
Nickel	2.9 B
Thallium	2.7 U
Vanadium	13.6 B
Zinc	15.6 B

TW01-33 FR-107	
Arsenic	9.5
Barium	322
Iron	1960
Manganese	2150
Thallium	3.7 B
Zinc	12.8 B

TW01-37 FR-121	
Arsenic	6.6
Barium	557
Copper	6.7 B
Iron	2540
Lead	8.7
Manganese	994
Nickel	9.9 B
Selenium	2.7 B
Zinc	48.4

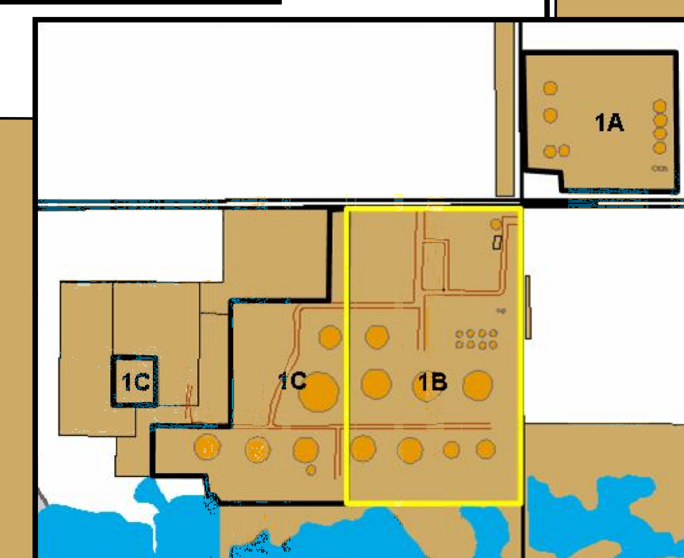
TW01-38 FR-118	
Arsenic	10.5
Barium	251
Copper	6.4 B
Iron	2970
Lead	5.7
Manganese	746
Nickel	6.3 B
Vanadium	1.3 B
Zinc	49.5

TW01-39 FR-115	
Aluminum	113 B
Barium	331
Iron	1040
Lead	7.2
Manganese	968
Zinc	55.2

TW01-40 FR-112	
Aluminum	777
Antimony	3.3 B
Barium	295
Iron	1390
Lead	4.4
Manganese	776
Nickel	3.5 B
Vanadium	1.1 B
Zinc	56.4

TW01-41 FR-104	
Antimony	5.3
Arsenic	7.5
Barium	137 B
Iron	372
Manganese	1010
Thallium	4.1 B
Zinc	12.3 B

Legend
- Groundwater Sample Points
- Roads
- Gravel/Dirt Road
- AOC-1B
- Refinery Tanks
- AOCs
- Wetland



Notes:

1. Results are posted in µg/l
   Hex Chrom posted in mg/l
2. Qualifiers:

   B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

- Exceeds TCEQ Tier 1 Residential PCL
- Exceeds Both EPA and TCEQ Limit
- SDL Exceeds Both EPA and TCEQ Screening Level

0 150 300
Feet

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON/G.WITT
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1B
Human Health
Metal Groundwater Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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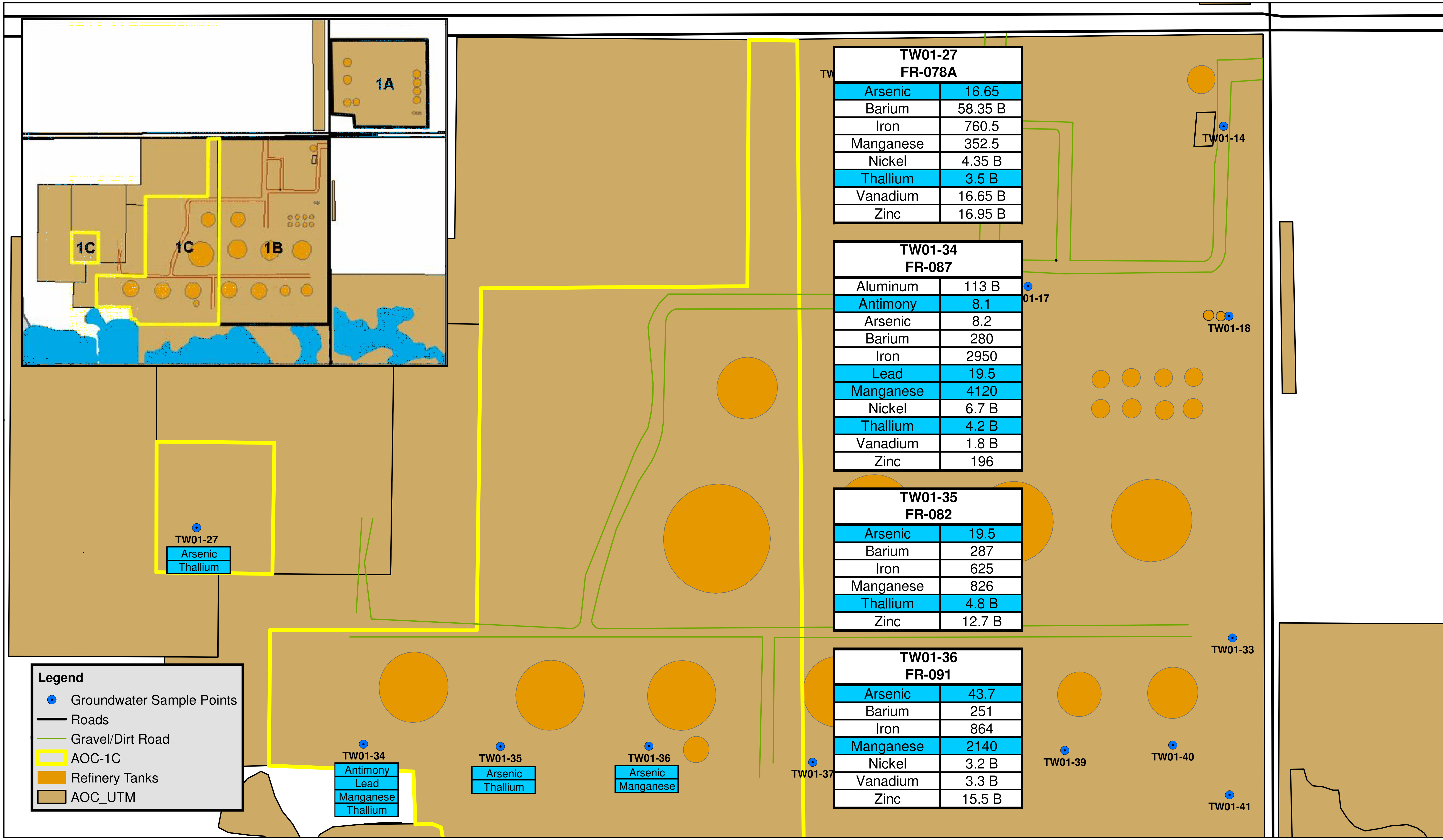
FIGURE
1B



TW01-27 FR-078A	
Arsenic	16.65
Barium	58.35 B
Iron	760.5
Manganese	352.5
Nickel	4.35 B
Thallium	3.5 B
Vanadium	16.65 B
Zinc	16.95 B

TW01-34 FR-087	
Aluminum	113 B
Antimony	8.1
Arsenic	8.2
Barium	280
Iron	2950
Lead	19.5
Manganese	4120
Nickel	6.7 B
Thallium	4.2 B
Vanadium	1.8 B
Zinc	196

TW01-35 FR-082	
Arsenic	19.5
Barium	287
Iron	625
Manganese	826
Thallium	4.8 B
Zinc	12.7 B

TW01-36 FR-091	
Arsenic	43.7
Barium	251
Iron	864
Manganese	2140
Nickel	3.2 B
Vanadium	3.3 B
Zinc	15.5 B

Notes:

1. Results are posted in µg/l

2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds Both EPA and TCEQ Limit

N

0 150 300

Feet

DATE DRAWN: 7/8/08

DATE REVISED: 4/1/08

DRAFTED BY: C. SEATON/G.WITT

CHECKED BY: S. HALASZ

APPROVED BY:

AOC-1C
Human Health
Metal Groundwater Distribution Map

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INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752

FILE NAME: Falcon Refinery Base Map

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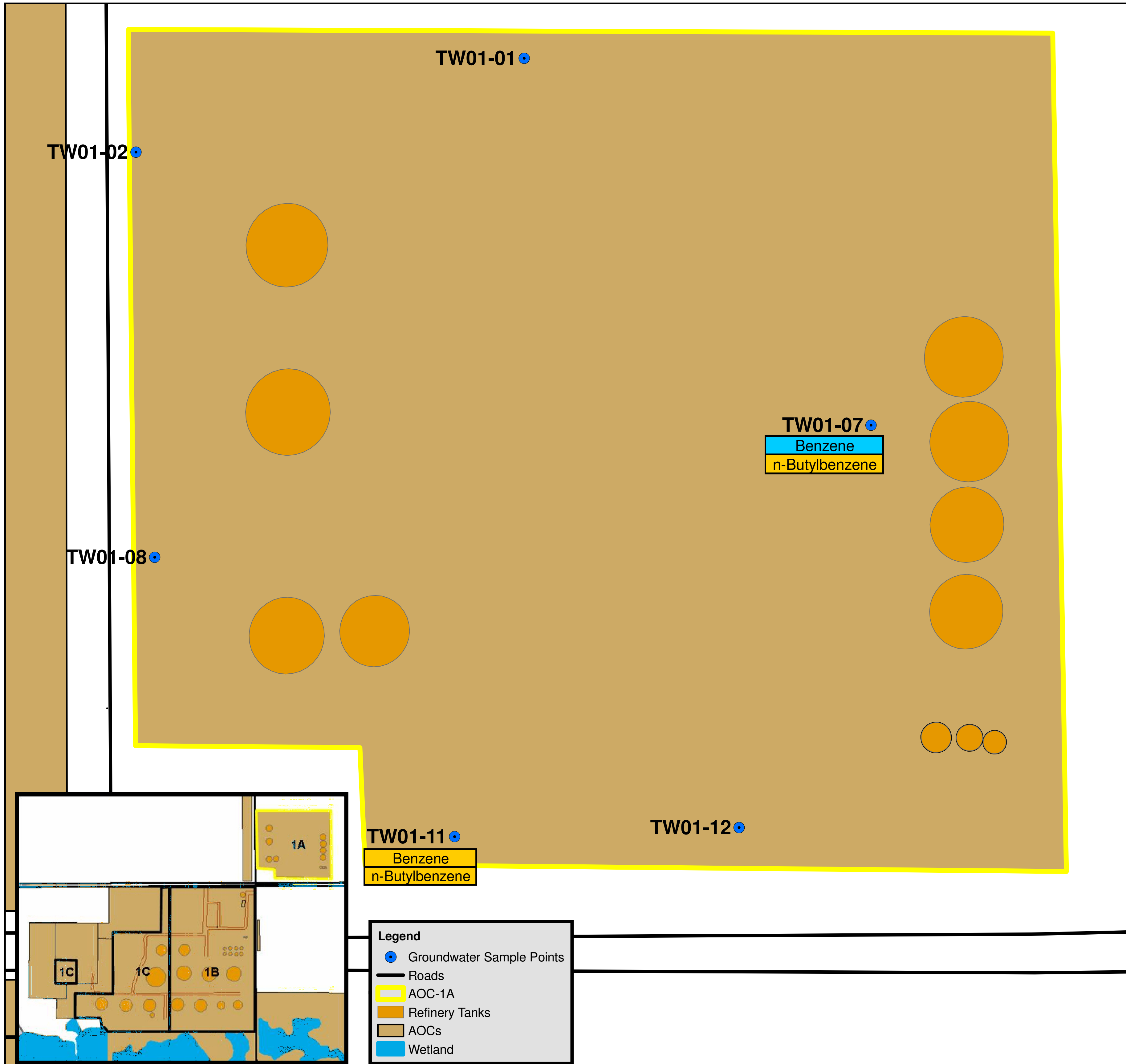
FIGURE

1C



TW01-01 FR-015	
1,1,1,2-Tetrachloroethane	0.00052 U
1,1,2,2-Tetrachloroethane	0.00046 U
1,2,3-Trichloropropane	0.00052 U
1,2-Dibromo-3-chloropropane	0.0015 U
1,2-Dibromoethane	0.00068 U
1,4-Dioxane	0.024 U
Acetone	0.0055 J
Bromodichloromethane	0.00033 U
Carbon tetrachloride	0.00052 U
Chloroform	0.00066 U
Cyclohexane	0.0323
Dibromochloromethane	0.00068 U
Ethylbenzene	0.0038
Isopropylbenzene	0.0013 J
n-Propylbenzene	0.00077 J

TW01-02 FR-018	
1,1,1,2-Tetrachloroethane	0.00052 U
1,1,2,2-Tetrachloroethane	0.00046 U
1,2,3-Trichloropropane	0.00052 U
1,2-Dibromo-3-chloropropane	0.0015 U
1,2-Dibromoethane	0.00068 U
1,4-Dioxane	0.024 U
Acetone	0.0068 J
Benzene	0.00065 J
Bromodichloromethane	0.00033 U
Carbon tetrachloride	0.00052 U
Chloroform	0.00066 U
Dibromochloromethane	0.00068 U
Ethylbenzene	0.00058 J
Xylene (total)	0.0019 J

TW01-07 FR-032	
1,2,4-Trimethylbenzene	0.0017 J
1,3,5-Trimethylbenzene	0.00069 J
Acetone	0.0047 J
Benzene	0.0145
Cyclohexane	0.00058 J
Ethylbenzene	0.002
n-Butylbenzene	0.0016 J
p-Isopropyltoluene	0.0011 J
1,1,1,2-Tetrachloroethane	0.00052 U
1,1,2,2-Tetrachloroethane	0.00046 U
1,2,3-Trichloropropane	0.00052 U
1,2-Dibromo-3-chloropropane	0.0015 U
1,2-Dibromoethane	0.00068 U
1,4-Dioxane	0.024 U
Bromodichloromethane	0.00033 U
Carbon tetrachloride	0.00052 U
Chloroform	0.00066 U
Dibromochloromethane	0.00068 U

TW01-08 FR-024	
1,1,1,2-Tetrachloroethane	0.00052 U
1,1,2,2-Tetrachloroethane	0.00046 U
1,2,3-Trichloropropane	0.00052 U
1,2-Dibromo-3-chloropropane	0.0015 U
1,2-Dibromoethane	0.00068 U
1,4-Dioxane	0.024 U
Acetone	0.0082 J
Bromodichloromethane	0.00033 U
Carbon tetrachloride	0.00052 U
Chloroform	0.00066 U
Dibromochloromethane	0.00068 U

TW01-11 FR-003	
1,1,1,2-Tetrachloroethane	0.00052 U
1,1,2,2-Tetrachloroethane	0.00046 U
1,2,3-Trichloropropane	0.00052 U
1,2-Dibromo-3-chloropropane	0.0015 U
1,2-Dibromoethane	0.00068 U
1,4-Dioxane	0.024 U
Acetone	0.0087 J
Benzene	0.003
Bromodichloromethane	0.00033 U
Carbon tetrachloride	0.00052 U
Chloroform	0.00066 U
Cyclohexane	0.00068 J
Dibromochloromethane	0.00068 U
Ethylbenzene	0.008
Isopropylbenzene	0.0068
n-Butylbenzene	0.0087
n-Propylbenzene	0.0112
tert-Butylbenzene	0.0168
Toluene	0.00058 J

TW01-12 FR-006	
1,1,1,2-Tetrachloroethane	0.00052 U
1,1,2,2-Tetrachloroethane	0.00046 U
1,2,3-Trichloropropane	0.00052 U
1,2-Dibromo-3-chloropropane	0.0015 U
1,2-Dibromoethane	0.00068 U
1,4-Dioxane	0.024 U
Acetone	0.0073 J
Bromodichloromethane	0.00033 U
Carbon tetrachloride	0.00052 U
Chloroform	0.00066 U
Dibromochloromethane	0.00068 U
Isopropylbenzene	0.0056
n-Propylbenzene	0.0048
tert-Butylbenzene	0.0023

Notes:

1. Results are posted in mg/l
2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

J = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

N

0 25 50

Feet

- Exceeds EPA Region 6 MSSL or MCL If Available
- Exceeds TCEQ Tier 1 Residential PCL
- Exceeds Both EPA and TCEQ Limit
- SDL Exceeds EPA Screening Level or MCL If Available
- SDL Exceeds Both EPA and TCEQ Screening Level

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON/G.WITT	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-1A Human Health VOC Groundwater Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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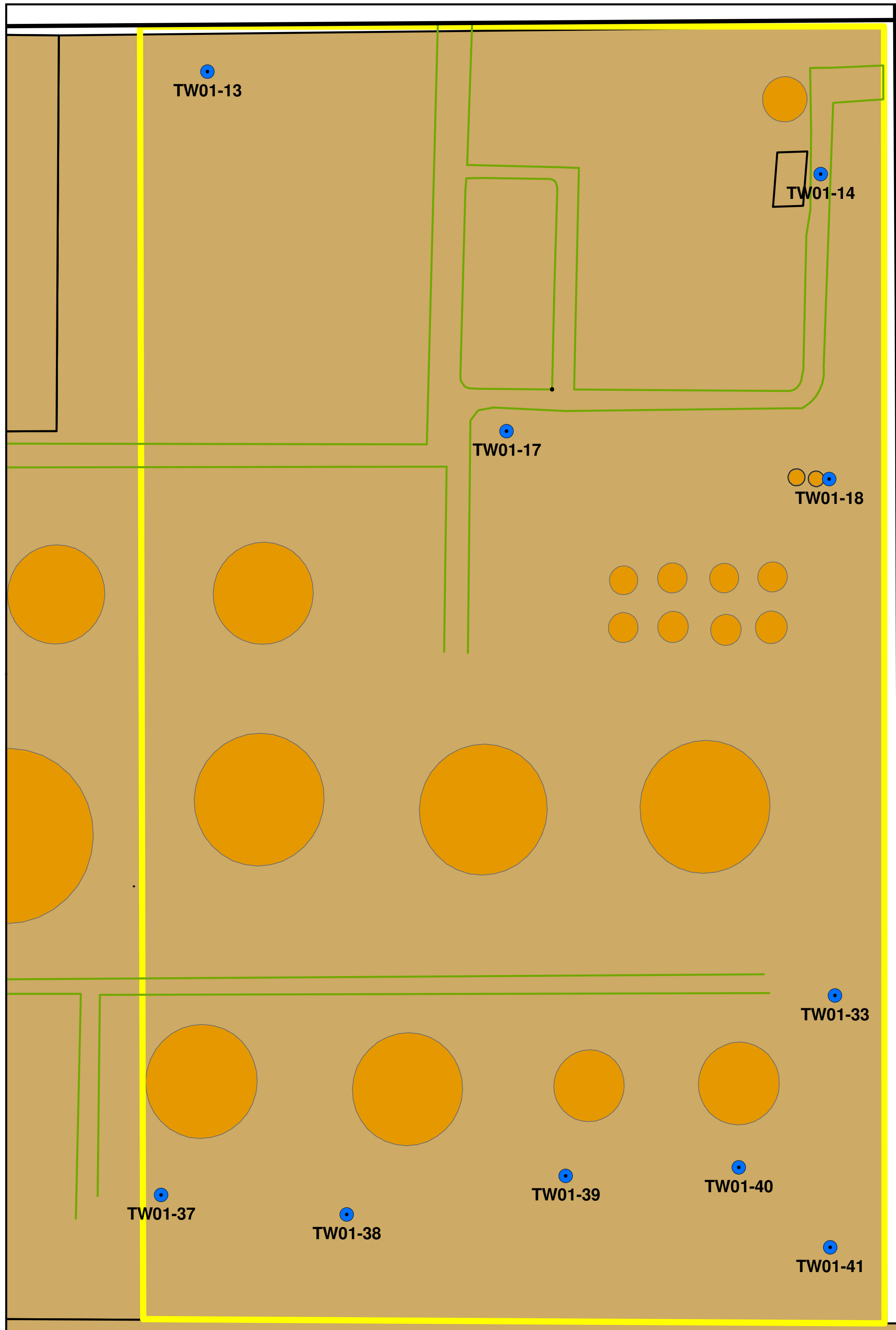
FIGURE
1D



TW01-13 FR-066	
1,1,1,2-Tetrachloroethane	0.00052 U
1,1,2,2-Tetrachloroethane	0.00046 U
1,2,3-Trichloropropane	0.00052 U
1,2-Dibromo-3-chloropropane	0.0015 U
1,2-Dibromoethane	0.00068 U
1,4-Dioxane	0.024 U
Bromodichloromethane	0.00033 U
Carbon tetrachloride	0.00052 U
Chloroform	0.00066 U
Dibromochloromethane	0.00068 U

TW01-14 FR-063	
1,1,1,2-Tetrachloroethane	0.00052 U
1,1,2,2-Tetrachloroethane	0.00046 U
1,2,3-Trichloropropane	0.00052 U
1,2-Dibromo-3-chloropropane	0.0015 U
1,2-Dibromoethane	0.00068 U
1,4-Dioxane	0.024 U
Acetone	0.0057 J
Bromodichloromethane	0.00033 U
Carbon tetrachloride	0.00052 U
Chloroform	0.00066 U
Dibromochloromethane	0.00068 U

TW01-17 FR-048A	
1,1,2,2-Tetrachloroethane	0.00042 U
1,2,3-Trichloropropane	0.00069 U
1,2-Dibromo-3-chloropropane	0.0011 U
1,2-Dibromoethane	0.00047 U
1,4-Dioxane	0.13 U
Acetone	0.004 J
Bromodichloromethane	0.00042 U
Carbon disulfide	0.00065 J
Carbon tetrachloride	0.00045 U
Chloroform	0.00054 U
Dibromochloromethane	0.00046 U

TW01-18 FR-052	
1,1,2,2-Tetrachloroethane	0.00042 U
1,2,3-Trichloropropane	0.00069 U
1,2-Dibromo-3-chloropropane	0.0011 U
1,2-Dibromoethane	0.00047 U
1,4-Dioxane	0.13 U
Acetone	0.0052 J
Benzene	0.0012 J
Bromodichloromethane	0.00042 U
Carbon tetrachloride	0.00045 U
Chloroform	0.00054 U
Dibromochloromethane	0.00046 U
Ethylbenzene	0.0034
Toluene	0.00083 J
Xylene (total)	0.0039 J

TW01-33 FR-107	
Bromodichloromethane	0.00042 U
Carbon tetrachloride	0.00045 U
Chloroform	0.00054 U
Dibromochloromethane	0.00046 U

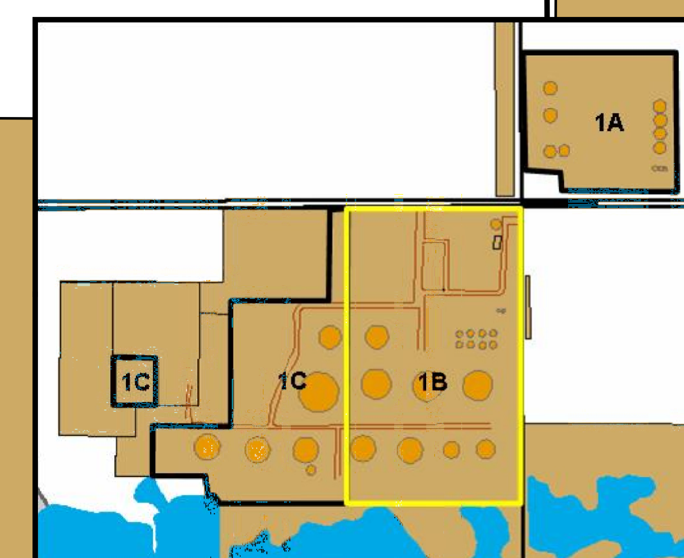
TW01-37 FR-121	
Acetone	0.005 J
Cyclohexane	0.00076 J

TW01-38 FR-118	
Acetone	0.0089 J

TW01-39 FR-115	
1,1,2,2-Tetrachloroethane	0.00042 U
1,2,3-Trichloropropane	0.00069 U
1,2-Dibromo-3-chloropropane	0.0011 U
1,2-Dibromoethane	0.00047 U
1,4-Dioxane	0.13 U
Acetone	0.0041 J

TW01-40 FR-112	
Acetone	0.0036 J

Legend
- Groundwater Sample Points
- Roads
- Gravel/Dirt Road
- AOC-1B
- Refinery Tanks
- AOCs
- Wetland



Notes:

1. Results are posted in mg/l
2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

J = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

- Exceeds EPA Region 6 MSSL or MCL If Available
- SDL Exceeds EPA Screening Level or MCL If Available
- SDL Exceeds Both EPA and TCEQ Screening Level

0 150 300
Feet

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

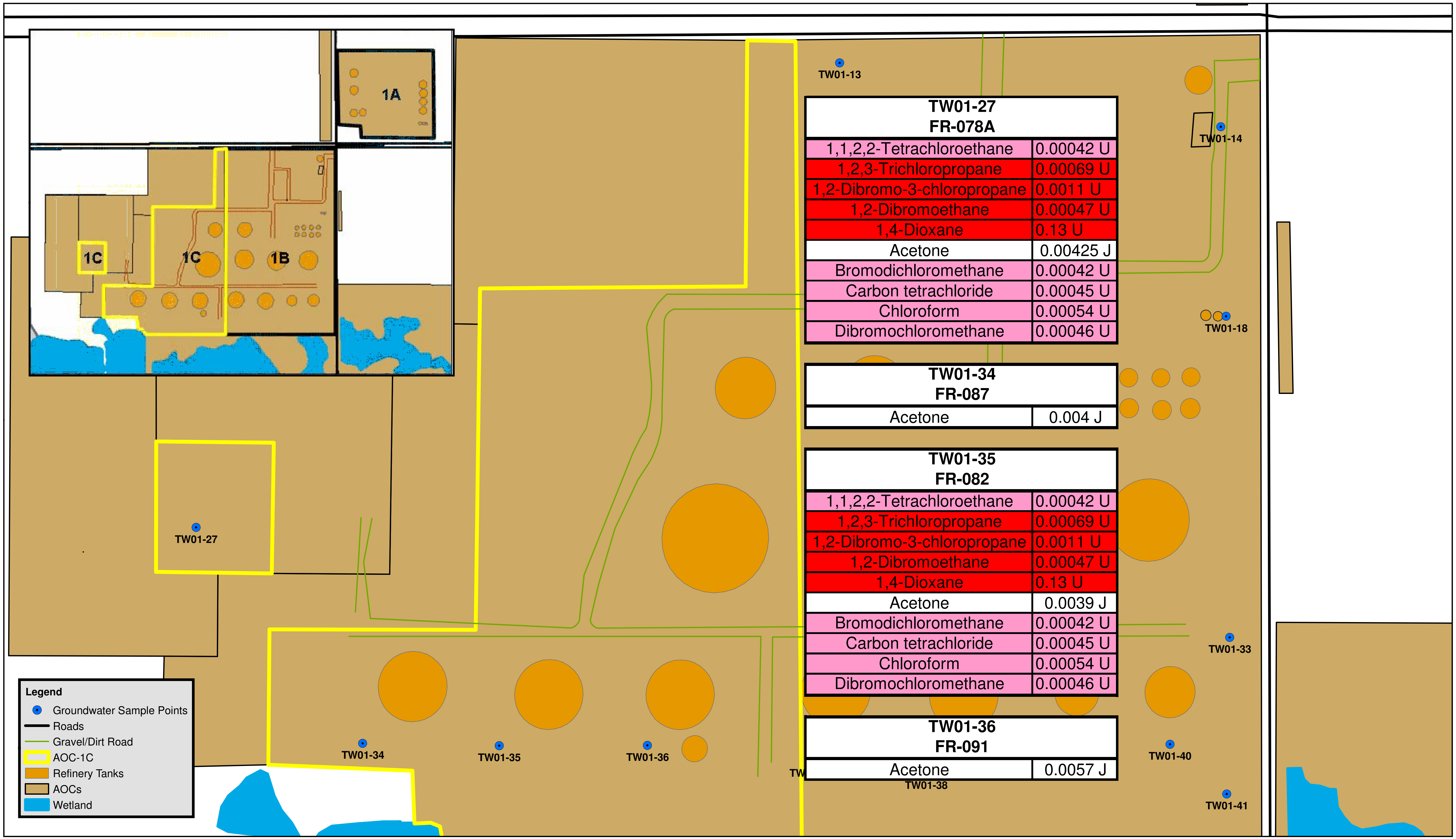
AOC-1B
Human Health
VOC Groundwater Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

KLEINFELDER
Bright People. Right Solutions.
1826 Kramer Lane, Suite M, Austin, Texas 78758
Phone: 512-926-6650 Fax: 512-833-5058
www.kleinfelder.com

FIGURE
1E



Notes:

1. Results are posted in mg/l
2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

J = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

SDL Exceeds EPA Screening Level or MCL If Available

SDL Exceeds Both EPA and TCEQ Screening Level

0 150 300

Feet

N

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON/G.WITT	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-1C
Human Health
VOC Groundwater Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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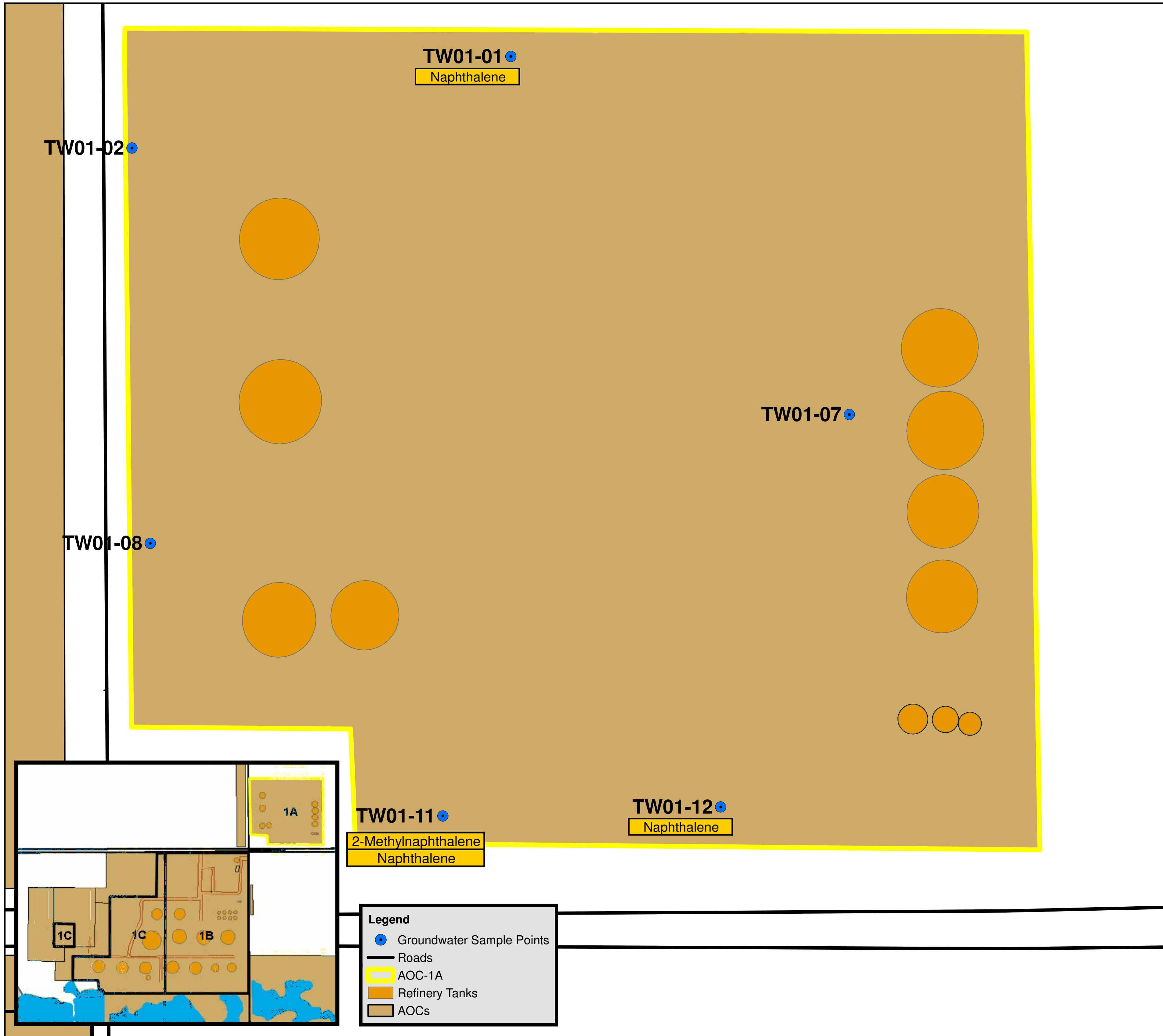
FIGURE
1F



TW01-01 FR-015	
1,4-Dichlorobenzene	0.0015 U
1-Methylnaphthalene	0.002 J
2,4-Dinitrotoluene	0.0024 U
2,6-Dinitrotoluene	0.0017 U
3,3'-Dichlorobenzidine	0.0037 U
4-Bromophenyl phenyl ether	0.0021 U
4-Chlorophenyl phenyl ether	0.0015 U
7,12-Dimethylbenz(a)anthracene	0.0050 U
Benzenethiol	0.010 U
Benzo(a)anthracene	0.000055 U
Benzo(b)fluoranthene	0.000056 U
Benzo(k)fluoranthene	0.000046 U
bis(2-Chloroethoxy)methane	0.0016 U
bis(2-Chloroethyl)ether	0.0012 U
bis(2-Ethylhexyl)phthalate	0.0015 J
Dibenzo(a,h)anthracene	0.0013 U
Hexachlorobenzene	0.0019 U
Hexachlorobutadiene	0.0019 U
Hexachlorobutadiene	0.0018 U
Indeno(1,2,3-cd)pyrene	0.0024 U
Naphthalene	0.0273
N-Nitroso-di-n-propylamine	0.0017 U
Pentachlorophenol	0.0040 U
Quinoline	0.0010 U

TW01-08 FR-024	
1,4-Dichlorobenzene	0.0015 U
2,4-Dinitrotoluene	0.0024 U
2,6-Dinitrotoluene	0.0017 U
3,3'-Dichlorobenzidine	0.0037 U
4-Bromophenyl phenyl ether	0.0021 U
4-Chlorophenyl phenyl ether	0.0015 U
7,12-Dimethylbenz(a)anthracene	0.0050 U
Benzenethiol	0.010 U
Benzo(a)anthracene	0.000055 U
Benzo(b)fluoranthene	0.000056 U
Benzo(k)fluoranthene	0.000046 U
bis(2-Chloroethoxy)methane	0.0016 U
bis(2-Chloroethyl)ether	0.0012 U
bis(2-Ethylhexyl)phthalate	0.0016 J
Dibenzo(a,h)anthracene	0.0013 U
Hexachlorobenzene	0.0019 U
Hexachlorobutadiene	0.0019 U
Hexachlorobutadiene	0.0018 U
Indeno(1,2,3-cd)pyrene	0.0024 U
N-Nitroso-di-n-propylamine	0.0017 U
Pentachlorophenol	0.0040 U
Quinoline	0.0010 U

TW01-02 FR-018	
1,4-Dichlorobenzene	0.0015 U
2,4-Dinitrotoluene	0.0024 U
2,6-Dinitrotoluene	0.0017 U
3,3'-Dichlorobenzidine	0.0037 U
4-Bromophenyl phenyl ether	0.0021 U
4-Chlorophenyl phenyl ether	0.0015 U
7,12-Dimethylbenz(a)anthracene	0.0050 U
Benzenethiol	0.010 U
Benzo(a)anthracene	0.000055 U
Benzo(b)fluoranthene	0.000056 U
Benzo(k)fluoranthene	0.000046 U
bis(2-Chloroethoxy)methane	0.0016 U
bis(2-Chloroethyl)ether	0.0012 U
bis(2-Ethylhexyl)phthalate	0.0018 J
Dibenzo(a,h)anthracene	0.0013 U
Hexachlorobenzene	0.0019 U
Hexachlorobutadiene	0.0019 U
Hexachlorobutadiene	0.0018 U
Indeno(1,2,3-cd)pyrene	0.0024 U
Naphthalene	0.0021 J
N-Nitroso-di-n-propylamine	0.0017 U
Pentachlorophenol	0.0040 U
Quinoline	0.0010 U

TW01-11 FR-003	
1,4-Dichlorobenzene	0.0015 U
1-Methylnaphthalene	0.0647
2,4-Dinitrotoluene	0.0024 U
2,6-Dinitrotoluene	0.0017 U
2-Methylnaphthalene	0.0625
3,3'-Dichlorobenzidine	0.0037 U
4-Bromophenyl phenyl ether	0.0021 U
4-Chlorophenyl phenyl ether	0.0015 U
7,12-Dimethylbenz(a)anthracene	0.0050 U
Benzenethiol	0.010 U
Benzo(a)anthracene	0.000055 U
Benzo(b)fluoranthene	0.000056 U
Benzo(k)fluoranthene	0.000046 U
bis(2-Chloroethoxy)methane	0.0016 U
bis(2-Chloroethyl)ether	0.0012 U
bis(2-Ethylhexyl)phthalate	0.0026 J
Dibenzo(a,h)anthracene	0.0013 U
Hexachlorobenzene	0.0019 U
Hexachlorobutadiene	0.0019 U
Hexachlorobutadiene	0.0018 U
Indeno(1,2,3-cd)pyrene	0.0024 U
Naphthalene	0.163
N-Nitroso-di-n-propylamine	0.0017 U
Pentachlorophenol	0.0040 U
Quinoline	0.0010 U

TW01-07 FR-032	
1,4-Dichlorobenzene	0.0015 U
1-Methylnaphthalene	0.0155
2,4-Dinitrotoluene	0.0024 U
2,6-Dinitrotoluene	0.0017 U
2-Methylnaphthalene	0.0168
3,3'-Dichlorobenzidine	0.0037 U
4-Bromophenyl phenyl ether	0.0021 U
4-Chlorophenyl phenyl ether	0.0015 U
7,12-Dimethylbenz(a)anthracene	0.0050 U
Benzenethiol	0.010 U
Benzo(a)anthracene	0.000055 U
Benzo(b)fluoranthene	0.000056 U
Benzo(k)fluoranthene	0.000046 U
bis(2-Chloroethoxy)methane	0.0016 U
bis(2-Chloroethyl)ether	0.0012 U
Dibenzo(a,h)anthracene	0.0013 U
Diethyl phthalate	0.0025 J
Hexachlorobenzene	0.0019 U
Hexachlorobutadiene	0.0019 U
Hexachlorobutadiene	0.0018 U
Indeno(1,2,3-cd)pyrene	0.0024 U
Naphthalene	0.0053
N-Nitroso-di-n-propylamine	0.0017 U
Pentachlorophenol	0.0040 U
Quinoline	0.0010 U

TW01-12 FR-006	
1,4-Dichlorobenzene	0.0015 U
1-Methylnaphthalene	0.0109
2,4-Dinitrotoluene	0.0024 U
2,6-Dinitrotoluene	0.0017 U
2-Methylnaphthalene	0.0102
3,3'-Dichlorobenzidine	0.0037 U
4-Bromophenyl phenyl ether	0.0021 U
4-Chlorophenyl phenyl ether	0.0015 U
7,12-Dimethylbenz(a)anthracene	0.0050 U
Benzenethiol	0.010 U
Benzo(a)anthracene	0.000055 U
Benzo(b)fluoranthene	0.000056 U
Benzo(k)fluoranthene	0.000046 U
bis(2-Chloroethoxy)methane	0.0016 U
bis(2-Chloroethyl)ether	0.0012 U
Dibenzo(a,h)anthracene	0.0013 U
Hexachlorobenzene	0.0019 U
Hexachlorobutadiene	0.0019 U
Hexachlorobutadiene	0.0018 U
Indeno(1,2,3-cd)pyrene	0.0024 U
Naphthalene	0.0256
N-Nitroso-di-n-propylamine	0.0017 U
Pentachlorophenol	0.0040 U
Quinoline	0.0010 U

Notes:

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Exceeds EPA Region 6 MSSL or MCL If Available

SDL Exceeds EPA Screening Level or MCL If Available

SDL Exceeds TCEQ Screening Level

SDL Exceeds Both EPA and TCEQ Screening Level

N

0 90 180

Feet

DATE DRAWN: 4/30/08	DATE REVISED: 4/01/09
DRAFTED BY: C. SEATON/G.WITT	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-1A Human Health SVOC Groundwater Distribution Map

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INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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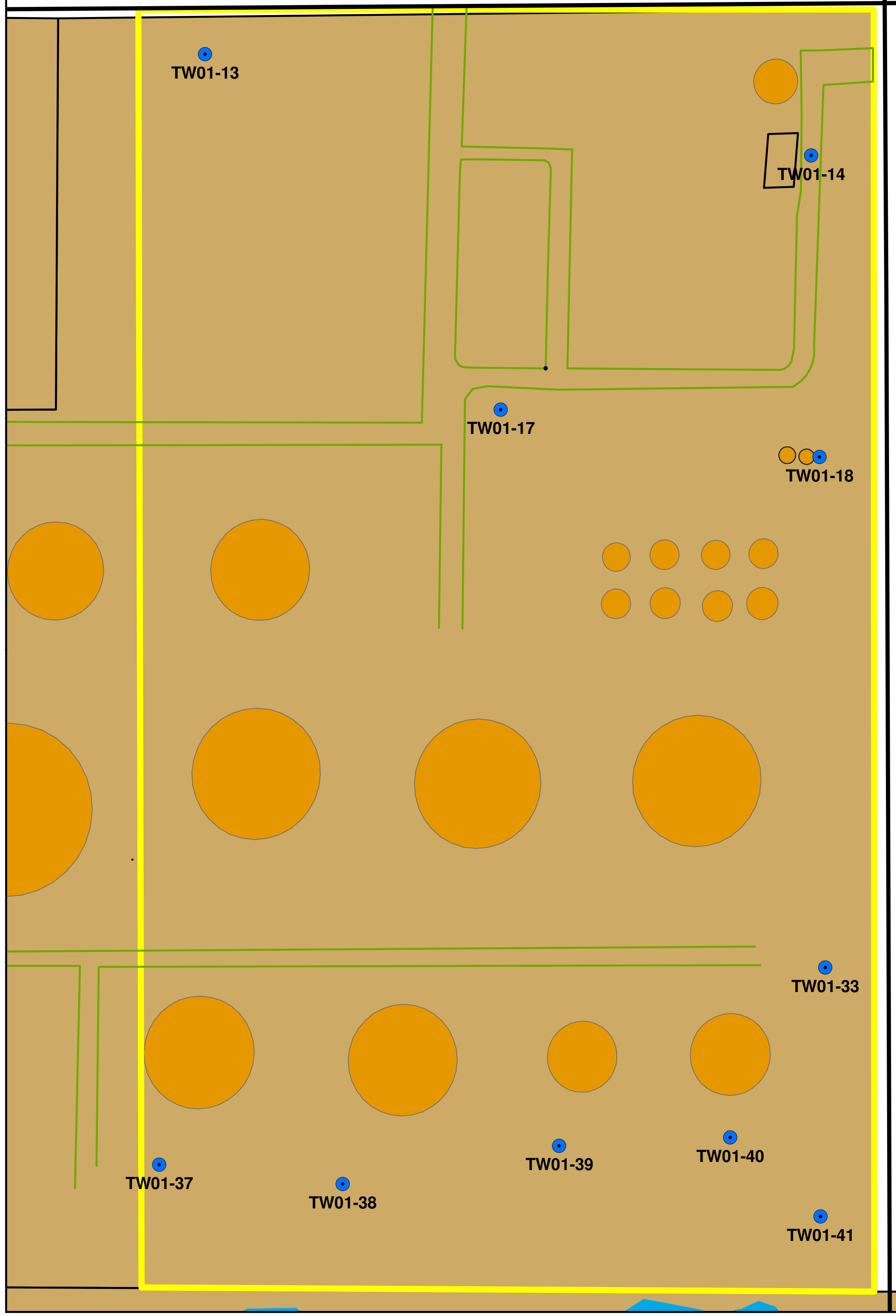
FIGURE
1G



TW01-13 FR-066	
1,4-Dichlorobenzene	0.0015 U
2,4-Dinitrotoluene	0.0024 U
2,6-Dinitrotoluene	0.0017 U
3,3'-Dichlorobenzidine	0.0037 U
4-Bromophenyl phenyl ether	0.0021 U
4-Chlorophenyl phenyl ether	0.0015 U
7,12-Dimethylbenz(a)anthracene	0.0050 U
Benzenethiol	0.010 U
Benzo(a)anthracene	0.000055 U
Benzo(b)fluoranthene	0.000056 U
Benzo(k)fluoranthene	0.000046 U
bis(2-Chloroethoxy)methane	0.0016 U
bis(2-Chloroethyl)ether	0.0012 U
Dibenzo(a,h)anthracene	0.0013 U
Hexachlorobenzene	0.0019 U
Hexachlorobutadiene	0.0019 U
Hexachlorobutadiene	0.0018 U
Indeno(1,2,3-cd)pyrene	0.0024 U
N-Nitroso-di-n-propylamine	0.0017 U
Pentachlorophenol	0.0040 U
Quinoline	0.0010 U

TW01-14 FR-063	
1,4-Dichlorobenzene	0.0016 U
2,4-Dinitrotoluene	0.0025 U
2,6-Dinitrotoluene	0.0017 U
3,3'-Dichlorobenzidine	0.0038 U
4-Bromophenyl phenyl ether	0.0022 U
4-Chlorophenyl phenyl ether	0.0015 U
7,12-Dimethylbenz(a)anthracene	0.0051 U
Benzenethiol	0.010 U
Benzo(a)anthracene	0.000056 U
Benzo(b)fluoranthene	0.000057 U
Benzo(k)fluoranthene	0.000047 U
bis(2-Chloroethoxy)methane	0.0016 U
bis(2-Chloroethyl)ether	0.0012 U
Dibenzo(a,h)anthracene	0.0013 U
Hexachlorobenzene	0.0019 U
Hexachlorobutadiene	0.0020 U
Hexachlorobutadiene	0.0018 U
Indeno(1,2,3-cd)pyrene	0.0024 U
N-Nitroso-di-n-propylamine	0.0017 U
Quinoline	0.0010 U

TW01-17 FR-048A	
1,4-Dichlorobenzene	0.0016 U
2,4-Dinitrotoluene	0.0025 U
2,6-Dinitrotoluene	0.0017 U
3,3'-Dichlorobenzidine	0.0038 U
4-Bromophenyl phenyl ether	0.0022 U
4-Chlorophenyl phenyl ether	0.0015 U
7,12-Dimethylbenz(a)anthracene	0.0052 U
Benzenethiol	0.010 U
Benzo(a)anthracene	0.00078 U
Benzo(a)pyrene	0.0016 U
Benzo(b)fluoranthene	0.00078 U
Benzo(k)fluoranthene	0.00082 U
bis(2-Chloroethoxy)methane	0.0016 U
bis(2-Chloroethyl)ether	0.0012 U
Dibenzo(a,h)anthracene	0.0013 U
Hexachlorobenzene	0.0019 U
Hexachlorobutadiene	0.0016 U
Indeno(1,2,3-cd)pyrene	0.0025 U
N-Nitroso-di-n-propylamine	0.0017 U
Pentachlorophenol	0.0041 U
Quinoline	0.0010 U

TW01-18 FR-052	
1,4-Dichlorobenzene	0.0016 U
2,4-Dinitrotoluene	0.0025 U
2,6-Dinitrotoluene	0.0017 U
3,3'-Dichlorobenzidine	0.0038 U
4-Bromophenyl phenyl ether	0.0022 U
4-Chlorophenyl phenyl ether	0.0015 U
7,12-Dimethylbenz(a)anthracene	0.0051 U
Benzenethiol	0.010 U
Benzo(a)anthracene	0.0014 U
Benzo(a)anthracene	0.000056 U
Benzo(a)pyrene	0.0016 U
Benzo(b)fluoranthene	0.0015 U
Benzo(b)fluoranthene	0.000057 U
Benzo(k)fluoranthene	0.0016 U
Benzo(k)fluoranthene	0.000047 U
bis(2-Chloroethoxy)methane	0.0016 U
bis(2-Chloroethyl)ether	0.0012 U
Dibenzo(a,h)anthracene	0.0013 U
Hexachlorobenzene	0.0019 U
Hexachlorobutadiene	0.0020 U
Hexachlorobutadiene	0.0012 U
Indeno(1,2,3-cd)pyrene	0.0024 U
N-Nitroso-di-n-propylamine	0.0017 U
Pentachlorophenol	0.0041 U
Quinoline	0.0010 U

TW01-33 FR-107	
7,12-Dimethylbenz(a)anthracene	0.0050 U
Benzenethiol	0.010 U
Benzo(a)anthracene	0.000055 U
Benzo(b)fluoranthene	0.000056 U
Benzo(k)fluoranthene	0.000046 U
bis(2-Chloroethoxy)methane	0.0016 U
bis(2-Chloroethyl)ether	0.0012 U
Dibenzo(a,h)anthracene	0.0013 U
Hexachlorobenzene	0.0019 U
Hexachlorobutadiene	0.0019 U
Hexachlorobutadiene	0.0012 U
Indeno(1,2,3-cd)pyrene	0.0024 U
N-Nitroso-di-n-propylamine	0.0017 U
Pentachlorophenol	0.0040 U
Quinoline	0.0010 U

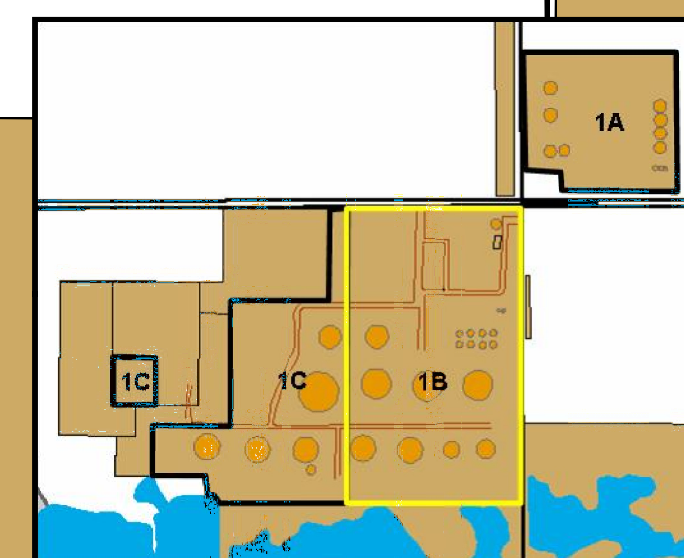
TW01-37 FR-121	
1-Phenylethanol	0.0026 J

TW01-39 FR-115	
1,4-Dichlorobenzene	0.0015 U
2,4-Dinitrotoluene	0.0024 U
2,6-Dinitrotoluene	0.0017 U
3,3'-Dichlorobenzidine	0.0037 U
4-Bromophenyl phenyl ether	0.0021 U
4-Chlorophenyl phenyl ether	0.0015 U
7,12-Dimethylbenz(a)anthracene	0.0050 U

TW01-41 FR-104	
Di-n-butyl phthalate	0.0063

Legend

- Groundwater Sample Points
- Roads
- Gravel/Dirt Road
- AOC-1B
- Refinery Tanks
- AOCs
- Wetland



Notes:

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- SDL Exceeds EPA Screening Level or MCL If Available
- SDL Exceeds TCEQ Screening Level
- SDL Exceeds Both EPA and TCEQ Screening Level

N

0 150 300

Feet

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON/G.WITT	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-1B
Human Health
SVOC Groundwater Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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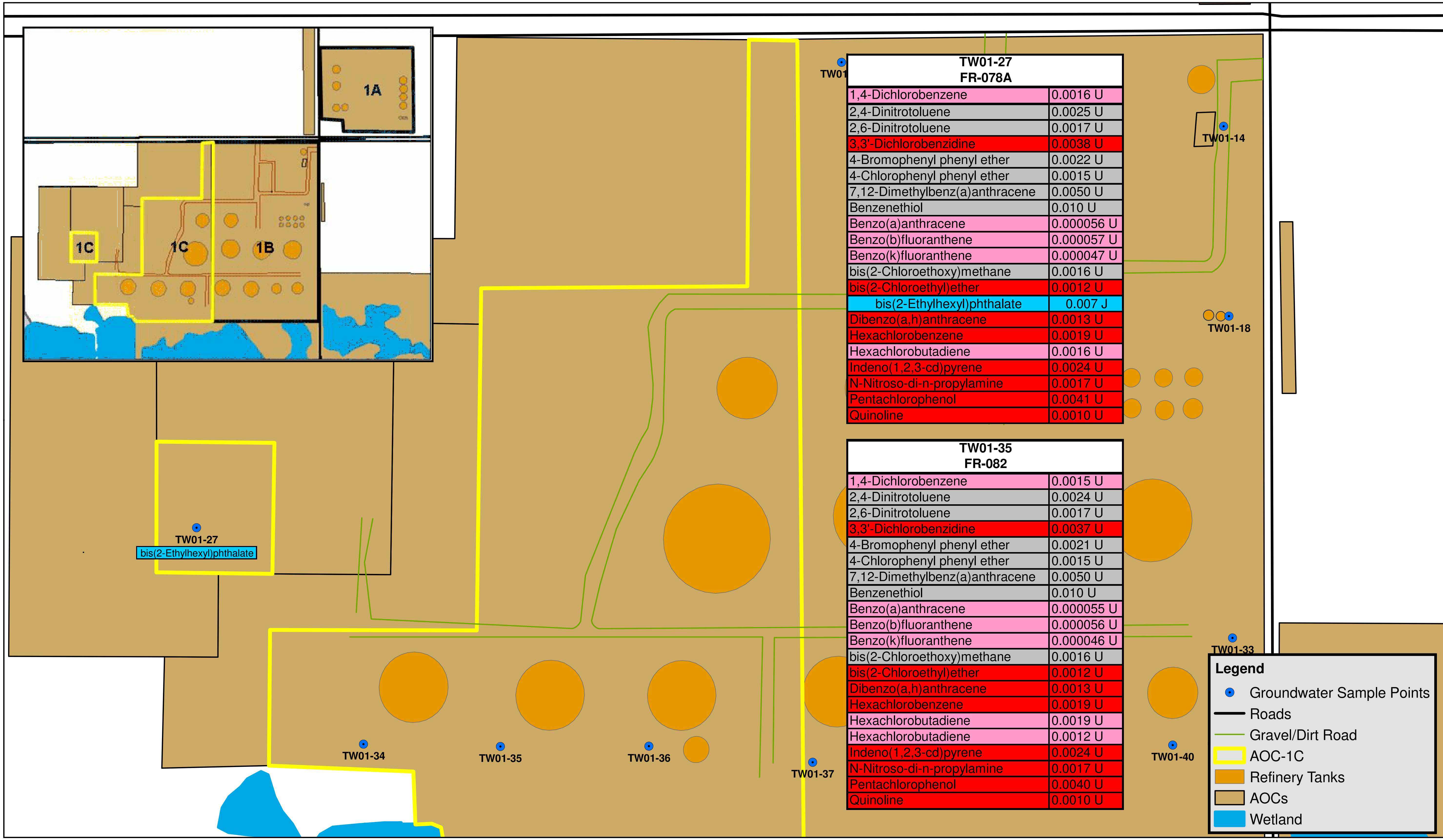
FIGURE

1H



TW01-27 FR-078A	
1,4-Dichlorobenzene	0.0016 U
2,4-Dinitrotoluene	0.0025 U
2,6-Dinitrotoluene	0.0017 U
3,3'-Dichlorobenzidine	0.0038 U
4-Bromophenyl phenyl ether	0.0022 U
4-Chlorophenyl phenyl ether	0.0015 U
7,12-Dimethylbenz(a)anthracene	0.0050 U
Benzenethiol	0.010 U
Benzo(a)anthracene	0.000056 U
Benzo(b)fluoranthene	0.000057 U
Benzo(k)fluoranthene	0.000047 U
bis(2-Chloroethoxy)methane	0.0016 U
bis(2-Chloroethyl)ether	0.0012 U
bis(2-Ethylhexyl)phthalate	0.007 J
Dibenzo(a,h)anthracene	0.0013 U
Hexachlorobenzene	0.0019 U
Hexachlorobutadiene	0.0016 U
Indeno(1,2,3-cd)pyrene	0.0024 U
N-Nitroso-di-n-propylamine	0.0017 U
Pentachlorophenol	0.0041 U
Quinoline	0.0010 U

TW01-35 FR-082	
1,4-Dichlorobenzene	0.0015 U
2,4-Dinitrotoluene	0.0024 U
2,6-Dinitrotoluene	0.0017 U
3,3'-Dichlorobenzidine	0.0037 U
4-Bromophenyl phenyl ether	0.0021 U
4-Chlorophenyl phenyl ether	0.0015 U
7,12-Dimethylbenz(a)anthracene	0.0050 U
Benzenethiol	0.010 U
Benzo(a)anthracene	0.000055 U
Benzo(b)fluoranthene	0.000056 U
Benzo(k)fluoranthene	0.000046 U
bis(2-Chloroethoxy)methane	0.0016 U
bis(2-Chloroethyl)ether	0.0012 U
Dibenzo(a,h)anthracene	0.0013 U
Hexachlorobenzene	0.0019 U
Hexachlorobutadiene	0.0019 U
Hexachlorobutadiene	0.0012 U
Indeno(1,2,3-cd)pyrene	0.0024 U
N-Nitroso-di-n-propylamine	0.0017 U
Pentachlorophenol	0.0040 U
Quinoline	0.0010 U

Notes:

1. Results are posted in mg/l
2. Qualifiers:
   - U = Undetected at the sample detection limit (SDL)
   - J = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds Both EPA and TCEQ Limit
SDL Exceeds EPA Screening Level or MCL If Available
SDL Exceeds TCEQ Screening Level
SDL Exceeds Both EPA and TCEQ Screening Level

N

0 150 300
Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON/G.WITT	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-1C
Human Health
SVOC Groundwater Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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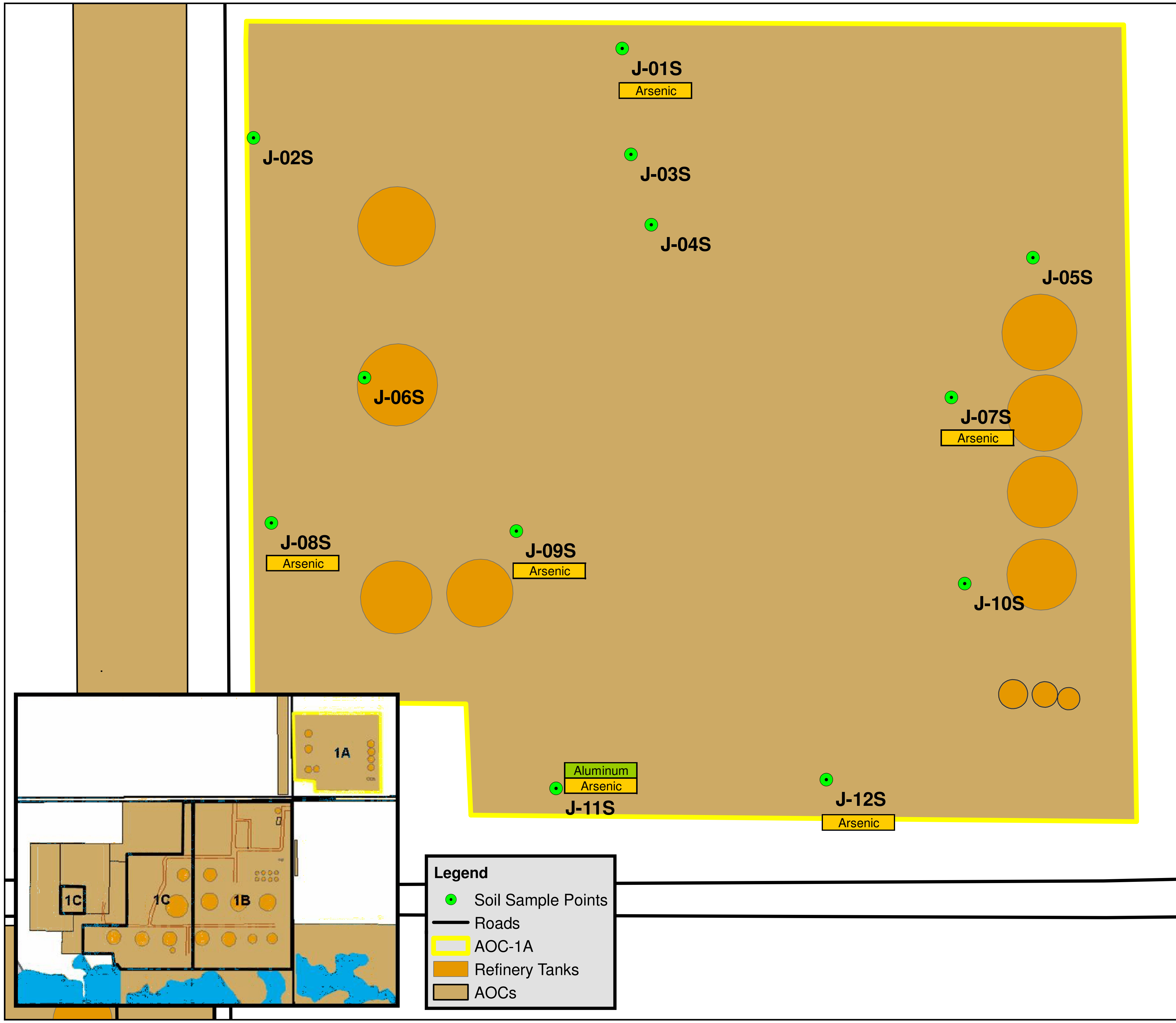
FIGURE
11



J-01 S FR-013	
Aluminum	3010
Arsenic	0.51 B
Barium	86.4
Beryllium	0.1 B
Chromium	2.8
Cobalt	0.74 B
Copper	1.7 B
Iron	1760
Lead	7
Manganese	66.4
Mercury	0.0083 B
Nickel	1 B
Vanadium	4.7 B
Zinc	40.7

J-02 S FR-016	
Aluminum	820
Barium	31.4
Beryllium	0.023 B
Chromium	0.9
Hex Chrom	1.3
Copper	0.99 B
Iron	540
Lead	4.6
Manganese	21.1
Mercury	0.0069 B
Nickel	0.29 B
Selenium	0.26 B
Vanadium	1.1 B
Zinc	23.6

J-03 S FR-009A	
Aluminum	509.5
Barium	24.3 B
Chromium	1.25
Copper	1.025 B
Iron	444.5
Lead	4.4
Manganese	11.9
Mercury	0.0096 B
Nickel	0.33 B
Selenium	0.305 B
Vanadium	1.15 B
Zinc	11.8

J-04 S FR-007	
Aluminum	786
Arsenic	0.23 B
Barium	23.4
Chromium	0.92 B
Copper	0.93 B
Iron	480
Lead	3.6
Manganese	15.7
Mercury	0.007 B
Nickel	0.35 B
Vanadium	1.3 B
Zinc	8.7

J-05 S FR-033	
Aluminum	1250
Arsenic	0.29 B
Barium	19 B
Beryllium	0.087 B
Chromium	0.77 B
Cobalt	0.47 B
Copper	0.93 B
Iron	1740
Lead	4.8
Manganese	11.5
Mercury	0.0014 B
Nickel	0.56 B
Vanadium	1.7 B
Zinc	10.4

J-06 S FR-019A	
Aluminum	609
Barium	6.25 B
Chromium	50.5 B
Copper	0.685 B
Iron	331
Lead	2.15
Manganese	9.3
Mercury	0.00535 B
Vanadium	0.985 B
Zinc	3.1

J-07 S FR-030	
Aluminum	2900
Antimony	0.54 B
Arsenic	2
Barium	1250
Beryllium	0.13 B
Cadmium	0.56
Chromium	13.3
Cobalt	2.5 B
Copper	23.5
Iron	4500
Lead	80.6
Manganese	39.6
Mercury	0.74
Nickel	4.3 B
Vanadium	5.1 B
Zinc	232

J-08 S FR-022	
Aluminum	5020
Arsenic	0.83 B
Barium	91.8
Beryllium	0.2 B
Chromium	3.6
Cobalt	1.3 B
Copper	3.2
Iron	3560
Lead	8.3
Manganese	102
Mercury	0.0014 B
Nickel	2.1 B
Vanadium	6.1
Zinc	80.3

J-09 S FR-025	
Aluminum	5460
Arsenic	1.2
Barium	25.9
Beryllium	0.24 B
Chromium	4.5
Hex Chrom	1.4
Cobalt	1.3 B
Copper	2.7
Iron	4280
Lead	8.9
Manganese	43.6
Mercury	0.013 B
Nickel	2.2 B
Vanadium	7.7
Zinc	16.6

J-10 S FR-027	
Aluminum	1670
Arsenic	0.31 B
Barium	13.9 B
Beryllium	0.094 B
Chromium	2.9
Hex Chrom	1.9
Cobalt	0.43 B
Copper	0.86 B
Iron	2170
Lead	6.9
Manganese	21.5
Mercury	0.0047 B
Nickel	0.76 B
Vanadium	2.4 B
Zinc	22.8

J-11 S FR-001	
Aluminum	14300
Arsenic	2.6
Barium	165
Beryllium	0.49
Chromium	11.3
Hex Chrom	3.1
Cobalt	3.3 B
Copper	5.1
Iron	7560
Lead	6
Manganese	121
Mercury	0.0037 B
Nickel	5.1
Selenium	0.37 B
Vanadium	22.3
Zinc	25.2

J-12 S FR-004	
Aluminum	3550
Arsenic	0.57 B
Barium	36
Beryllium	0.092 B
Chromium	2.3
Cobalt	0.61 B
Copper	1.1 B
Iron	1860
Lead	3.4
Manganese	37.3
Mercury	0.0065 B
Nickel	1.3 B
Vanadium	5.1
Zinc	6.1

Notes:

1. Results are posted in mg/kg
   Hex Chrom posted in mg/l
2. Qualifiers:

   B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds EPA Region 6 MSSL

Exceeds TCEQ Tier 1 Residential PCL

N

0 50 100

Feet

DATE DRAWN: 4/30/08 | DATE REVISED: 4/1/09

DRAFTED BY: C. SEATON/G.WITT

CHECKED BY: S. HALASZ

APPROVED BY:

AOC-1A Human Health Metal Surface Soil Distribution Map

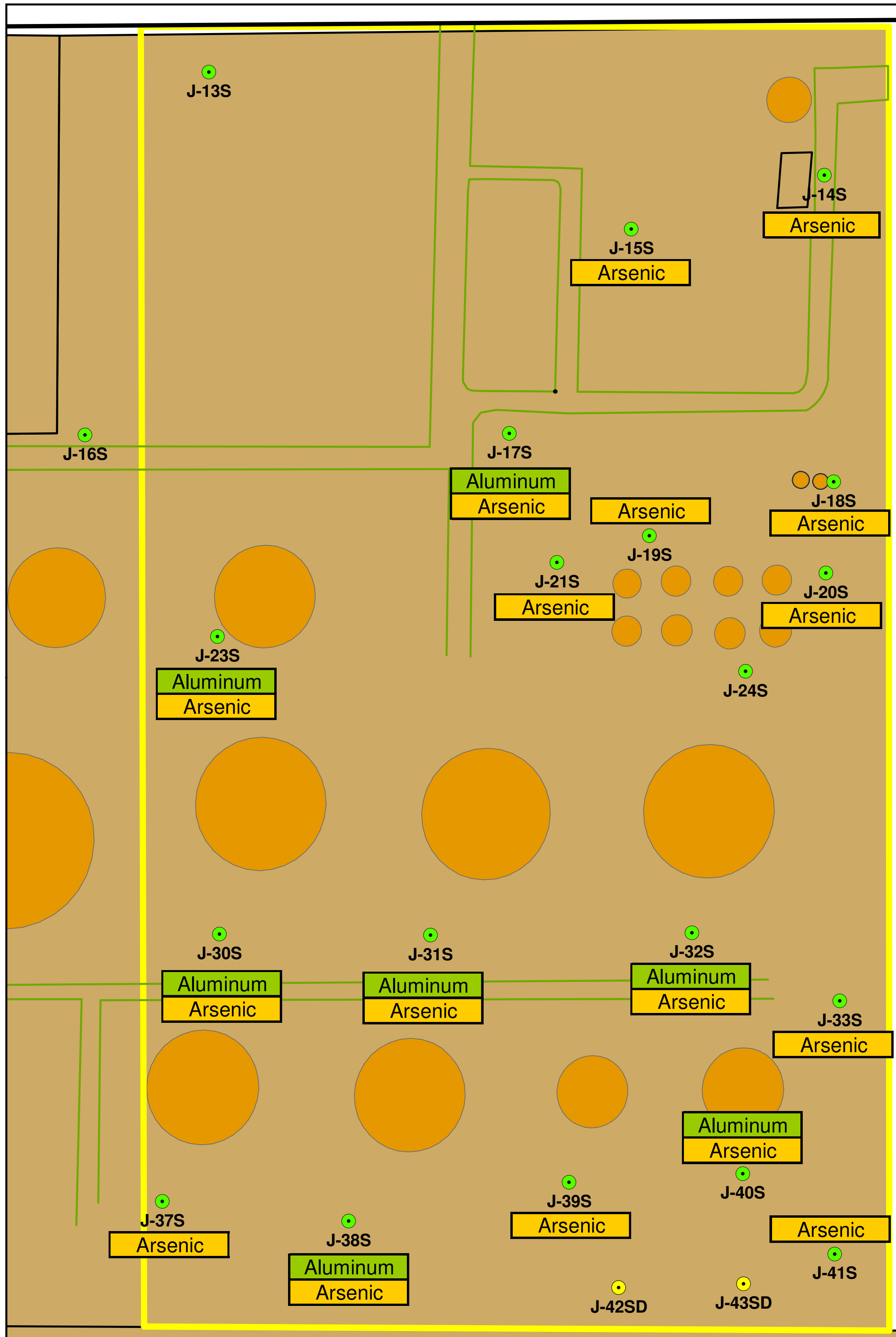
FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 | FILE NAME: Falcon Refinery Base Map

KLEINFELDER
Bright People. Right Solutions.
1826 Kramer Lane, Suite M, Austin, Texas 78758
Phone: 512-926-6650 Fax: 512-833-5058
www.kleinfelder.com

FIGURE

2A



J-14 S FR-061	
Aluminum	2710
Arsenic	0.66 B
Barium	88.9
Beryllium	0.049 B
Cadmium	0.17 B
Chromium	5.1
Cobalt	1.3 B
Copper	10.7
Iron	3820
Lead	55.8
Manganese	47.3
Mercury	0.0054 B
Nickel	1.7 B
Vanadium	4.1 B
Zinc	92.6

J-19 S FR-039A	
Aluminum	4375
Arsenic	1.8
Barium	93.95
Beryllium	0.2 B
Chromium	3.8
Cobalt	1.45 B
Copper	3.25
Iron	3095
Lead	19.75
Manganese	49.4
Mercury	0.049
Nickel	1.8 B
Vanadium	5.25
Zinc	26.15

J-30 S FR-094	
Aluminum	14400
Arsenic	3.1
Barium	98.6
Beryllium	0.52 B
Cadmium	0.14 B
Chromium	10.4
Cobalt	2.5 B
Copper	6.9
Iron	8740
Lead	23.8
Manganese	143
Mercury	0.024
Nickel	5.2
Vanadium	16.6
Zinc	79

J-37 S FR-119	
Aluminum	6190
Arsenic	2.2
Barium	381
Beryllium	0.27 B
Chromium	4.9
Cobalt	1.5 B
Copper	3.4
Iron	4810
Lead	6.7
Manganese	106
Mercury	0.0013 B
Nickel	2.5 B
Vanadium	13.2
Zinc	48.5

J-40 S FR-109	
Aluminum	9850
Arsenic	2.8
Barium	177
Beryllium	0.34 B
Chromium	7.8
Cobalt	2.8 B
Copper	4.5
Iron	7510
Lead	20.9
Manganese	155
Mercury	0.0079 B
Nickel	4.2 B
Vanadium	15.8
Zinc	31.8

J-15 S FR-035	
Aluminum	1440
Arsenic	2.6
Barium	26.9
Beryllium	0.078 B
Chromium	7.4
Cobalt	0.36 B
Copper	5.7
Iron	2430
Lead	18.9
Manganese	26.4
Mercury	0.011 B
Nickel	1.1 B
Vanadium	2.1 B
Zinc	31.1

J-20 S FR-044	
Aluminum	4570
Arsenic	0.86 B
Barium	61.5
Beryllium	0.22 B
Chromium	4
Cobalt	1.1 B
Copper	3.6
Iron	4620
Lead	17.1
Manganese	73.6
Mercury	0.013 B
Nickel	3.4 B
Vanadium	5.8
Zinc	30.2

J-31 S FR-099A	
Aluminum	15650
Arsenic	1.6
Barium	61.7
Beryllium	0.46 B
Chromium	9.6
Cobalt	2.2 B
Copper	4.7
Iron	8115
Lead	14.75
Manganese	77.5
Mercury	0.0215
Nickel	4.55 B
Vanadium	17.25
Zinc	26.05

J-38 S FR-116	
Aluminum	9900
Arsenic	2.4
Barium	944
Beryllium	0.37 B
Chromium	6.4
Hex Chrom	1.2
Cobalt	2.3 B
Copper	4.2
Iron	6570
Lead	8
Manganese	110
Mercury	0.0054 B
Nickel	3.5 B
Vanadium	16
Zinc	29.8

J-41 S FR-102	
Aluminum	4830
Arsenic	1.3
Barium	69.1
Beryllium	0.16 B
Cadmium	1.1
Chromium	3.7
Cobalt	1.2 B
Copper	4.8
Iron	3860
Lead	9.2
Manganese	65.6
Mercury	0.013 B
Nickel	2 B
Vanadium	7
Zinc	85.3

J-17 S FR-046	
Aluminum	7070
Arsenic	2
Barium	200
Beryllium	0.19 B
Cadmium	0.23 B
Chromium	9
Cobalt	1.7 B
Copper	8.1
Iron	8120
Lead	16.1
Manganese	146
Mercury	0.024
Nickel	8.6
Vanadium	10.6
Zinc	143

J-21 S FR-037	
Aluminum	4470
Arsenic	0.93 B
Barium	67.1
Beryllium	0.2 B
Chromium	8.3
Cobalt	1.3 B
Copper	2.5 B
Iron	3050
Lead	17.7
Manganese	77
Mercury	0.016 B
Nickel	4.1
Vanadium	4.9 B
Zinc	39.5

J-32 S FR-096	
Aluminum	14200
Arsenic	2.5
Barium	160
Beryllium	0.52 B
Chromium	8.9
Cobalt	3 B
Copper	5.2
Iron	7850
Lead	11.6
Manganese	191
Mercury	0.007 B
Nickel	5.3
Vanadium	16.2
Zinc	59

J-39 S FR-113	
Aluminum	5110
Arsenic	1.5
Barium	63.5
Beryllium	0.12 B
Chromium	4.5
Cobalt	1.3 B
Copper	3.7
Iron	3560
Lead	6.9
Manganese	102
Mercury	0.019 B
Nickel	2.4 B
Vanadium	7.8
Zinc	25.9

J-18 S FR-050	
Aluminum	3030
Arsenic	0.58 B
Barium	64.5
Beryllium	0.056 B
Cadmium	0.12 B
Chromium	2.8
Cobalt	0.62 B
Copper	2.5 B
Iron	2010
Lead	80.7
Manganese	49.4
Mercury	0.0088 B
Nickel	1.2 B
Vanadium	4.1 B
Zinc	35

J-23 S FR-054	
Aluminum	8090
Arsenic	1.7
Barium	66.6
Beryllium	0.23 B
Chromium	6.9
Hex Chrom	1.8
Cobalt	1.8 B
Copper	3.6
Iron	4900
Lead	9.9
Manganese	141
Mercury	0.012 B
Nickel	3.3 B
Vanadium	9.6
Zinc	44.1

J-33 S FR-105	
Aluminum	2600
Arsenic	1.4
Barium	41.4
Beryllium	0.075 B
Chromium	2
Cobalt	1 B
Copper	2.4 B
Iron	2050
Lead	5.4
Manganese	207
Mercury	0.0076 B
Nickel	1.3 B
Vanadium	4.8 B
Zinc	11.1

Legend

- Soil Sample Points
- Sediment Sample Points
- Roads
- Gravel/Dirt Road
- AOC-1B
- Refinery Tanks
- AOCs
- Wetland

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds EPA Region 6 MSSL

Exceeds TCEQ Tier 1 Residential PCL

0 150 300

Feet

DATE DRAWN: 2/23/09	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON/G.WITT	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-1B Human Metal Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

KLEINFELDER
Bright People. Right Solutions.
1826 Kramer Lane, Suite M, Austin, Texas 78758
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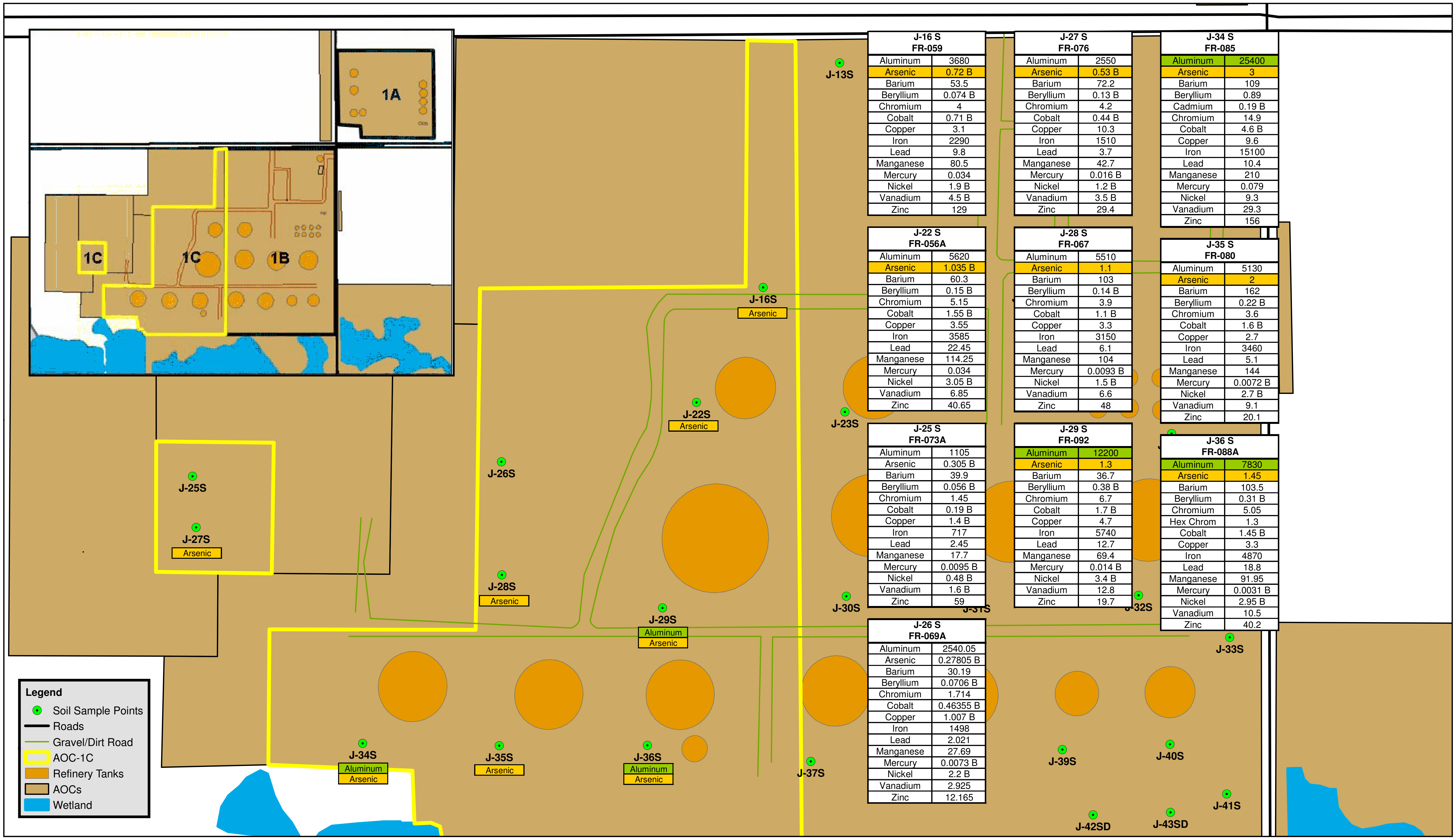
www.kleinfelder.com

FIGURE

2B



J-16 S FR-059	
Aluminum	3680
Arsenic	0.72 B
Barium	53.5
Beryllium	0.074 B
Chromium	4
Cobalt	0.71 B
Copper	3.1
Iron	2290
Lead	9.8
Manganese	80.5
Mercury	0.034
Nickel	1.9 B
Vanadium	4.5 B
Zinc	129

J-27 S FR-076	
Aluminum	2550
Arsenic	0.53 B
Barium	72.2
Beryllium	0.13 B
Chromium	4.2
Cobalt	0.44 B
Copper	10.3
Iron	1510
Lead	3.7
Manganese	42.7
Mercury	0.016 B
Nickel	1.2 B
Vanadium	3.5 B
Zinc	29.4

J-34 S FR-085	
Aluminum	25400
Arsenic	3
Barium	109
Beryllium	0.89
Cadmium	0.19 B
Chromium	14.9
Cobalt	4.6 B
Copper	9.6
Iron	15100
Lead	10.4
Manganese	210
Mercury	0.079
Nickel	9.3
Vanadium	29.3
Zinc	156

J-22 S FR-056A	
Aluminum	5620
Arsenic	1.035 B
Barium	60.3
Beryllium	0.15 B
Chromium	5.15
Cobalt	1.55 B
Copper	3.55
Iron	3585
Lead	22.45
Manganese	114.25
Mercury	0.034
Nickel	3.05 B
Vanadium	6.85
Zinc	40.65

J-28 S FR-067	
Aluminum	5510
Arsenic	1.1
Barium	103
Beryllium	0.14 B
Chromium	3.9
Cobalt	1.1 B
Copper	3.3
Iron	3150
Lead	6.1
Manganese	104
Mercury	0.0093 B
Nickel	1.5 B
Vanadium	6.6
Zinc	48

J-35 S FR-080	
Aluminum	5130
Arsenic	2
Barium	162
Beryllium	0.22 B
Chromium	3.6
Cobalt	1.6 B
Copper	2.7
Iron	3460
Lead	5.1
Manganese	144
Mercury	0.0072 B
Nickel	2.7 B
Vanadium	9.1
Zinc	20.1

J-25 S FR-073A	
Aluminum	1105
Arsenic	0.305 B
Barium	39.9
Beryllium	0.056 B
Chromium	1.45
Cobalt	0.19 B
Copper	1.4 B
Iron	717
Lead	2.45
Manganese	17.7
Mercury	0.0095 B
Nickel	0.48 B
Vanadium	1.6 B
Zinc	59

J-29 S FR-092	
Aluminum	12200
Arsenic	1.3
Barium	36.7
Beryllium	0.38 B
Chromium	6.7
Cobalt	1.7 B
Copper	4.7
Iron	5740
Lead	12.7
Manganese	69.4
Mercury	0.014 B
Nickel	3.4 B
Vanadium	12.8
Zinc	19.7

J-36 S FR-088A	
Aluminum	7830
Arsenic	1.45
Barium	103.5
Beryllium	0.31 B
Chromium	5.05
Hex Chrom	1.3
Cobalt	1.45 B
Copper	3.3
Iron	4870
Lead	18.8
Manganese	91.95
Mercury	0.0031 B
Nickel	2.95 B
Vanadium	10.5
Zinc	40.2

J-26 S FR-069A	
Aluminum	2540.05
Arsenic	0.27805 B
Barium	30.19
Beryllium	0.0706 B
Chromium	1.714
Cobalt	0.46355 B
Copper	1.007 B
Iron	1498
Lead	2.021
Manganese	27.69
Mercury	0.0073 B
Nickel	2.2 B
Vanadium	2.925
Zinc	12.165

Notes:

1. Results are posted in mg/kg
   Hex Chrom posted in mg/l
2. Qualifiers:

   B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds EPA Region 6 MSSL

Exceeds TCEQ Tier 1 Residential PCL

N

0 90 180
Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON/G.WITT	
CHECKED BY: S. HALASZ	
APPROVED BY:	

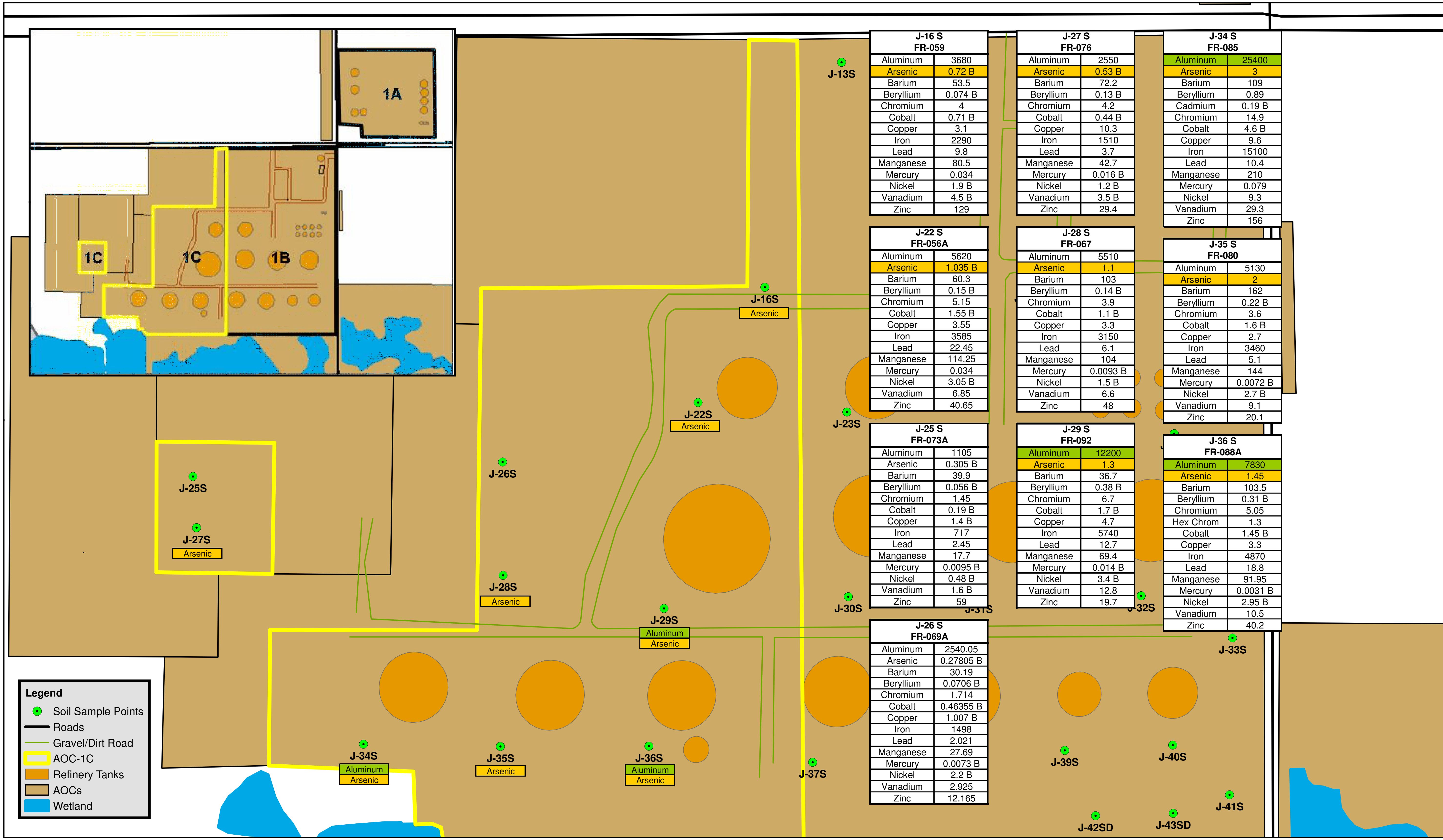
AOC-1C
Human Health
Metal Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

KLEINFELDER
Bright People. Right Solutions.
1826 Kramer Lane, Suite M, Austin, Texas 78758
Phone: 512-926-6650 Fax: 512-833-5058
www.kleinfelder.com

FIGURE
2B



J-16 S FR-059

Aluminum	3680
Arsenic	0.72 B
Barium	53.5
Beryllium	0.074 B
Chromium	4
Cobalt	0.71 B
Copper	3.1
Iron	2290
Lead	9.8
Manganese	80.5
Mercury	0.034
Nickel	1.9 B
Vanadium	4.5 B
Zinc	129

J-27 S FR-076

Aluminum	2550
Arsenic	0.53 B
Barium	72.2
Beryllium	0.13 B
Chromium	4.2
Cobalt	0.44 B
Copper	10.3
Iron	1510
Lead	3.7
Manganese	42.7
Mercury	0.016 B
Nickel	1.2 B
Vanadium	3.5 B
Zinc	29.4

J-34 S FR-085

Aluminum	25400
Arsenic	3
Barium	109
Beryllium	0.89
Cadmium	0.19 B
Chromium	14.9
Cobalt	4.6 B
Copper	9.6
Iron	15100
Lead	10.4
Manganese	210
Mercury	0.079
Nickel	9.3
Vanadium	29.3
Zinc	156

J-22 S FR-056A

Aluminum	5620
Arsenic	1.035 B
Barium	60.3
Beryllium	0.15 B
Chromium	5.15
Cobalt	1.55 B
Copper	3.55
Iron	3585
Lead	22.45
Manganese	114.25
Mercury	0.034
Nickel	3.05 B
Vanadium	6.85
Zinc	40.65

J-28 S FR-067

Aluminum	5510
Arsenic	1.1
Barium	103
Beryllium	0.14 B
Chromium	3.9
Cobalt	1.1 B
Copper	3.3
Iron	3150
Lead	6.1
Manganese	104
Mercury	0.0093 B
Nickel	1.5 B
Vanadium	6.6
Zinc	48

J-35 S FR-080

Aluminum	5130
Arsenic	2
Barium	162
Beryllium	0.22 B
Chromium	3.6
Cobalt	1.6 B
Copper	2.7
Iron	3460
Lead	5.1
Manganese	144
Mercury	0.0072 B
Nickel	2.7 B
Vanadium	9.1
Zinc	20.1

J-25 S FR-073A

Aluminum	1105
Arsenic	0.305 B
Barium	39.9
Beryllium	0.056 B
Chromium	1.45
Cobalt	0.19 B
Copper	1.4 B
Iron	717
Lead	2.45
Manganese	17.7
Mercury	0.0095 B
Nickel	0.48 B
Vanadium	1.6 B
Zinc	59

J-29 S FR-092

Aluminum	12200
Arsenic	1.3
Barium	36.7
Beryllium	0.38 B
Chromium	6.7
Cobalt	1.7 B
Copper	4.7
Iron	5740
Lead	12.7
Manganese	69.4
Mercury	0.014 B
Nickel	3.4 B
Vanadium	12.8
Zinc	19.7

J-36 S FR-088A

Aluminum	7830
Arsenic	1.45
Barium	103.5
Beryllium	0.31 B
Chromium	5.05
Hex Chrom	1.3
Cobalt	1.45 B
Copper	3.3
Iron	4870
Lead	18.8
Manganese	91.95
Mercury	0.0031 B
Nickel	2.95 B
Vanadium	10.5
Zinc	40.2

J-26 S FR-069A

Aluminum	2540.05
Arsenic	0.27805 B
Barium	30.19
Beryllium	0.0706 B
Chromium	1.714
Cobalt	0.46355 B
Copper	1.007 B
Iron	1498
Lead	2.021
Manganese	27.69
Mercury	0.0073 B
Nickel	2.2 B
Vanadium	2.925
Zinc	12.165

Notes:

1. Results are posted in mg/kg
   Hex Chrom posted in mg/l
2. Qualifiers:

   B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds EPA Region 6 MSSL

Exceeds TCEQ Tier 1 Residential PCL

N

0 90 180

Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON/G.WITT	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-1C
Human Health
Metal Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 | FILE NAME: Falcon Refinery Base Map

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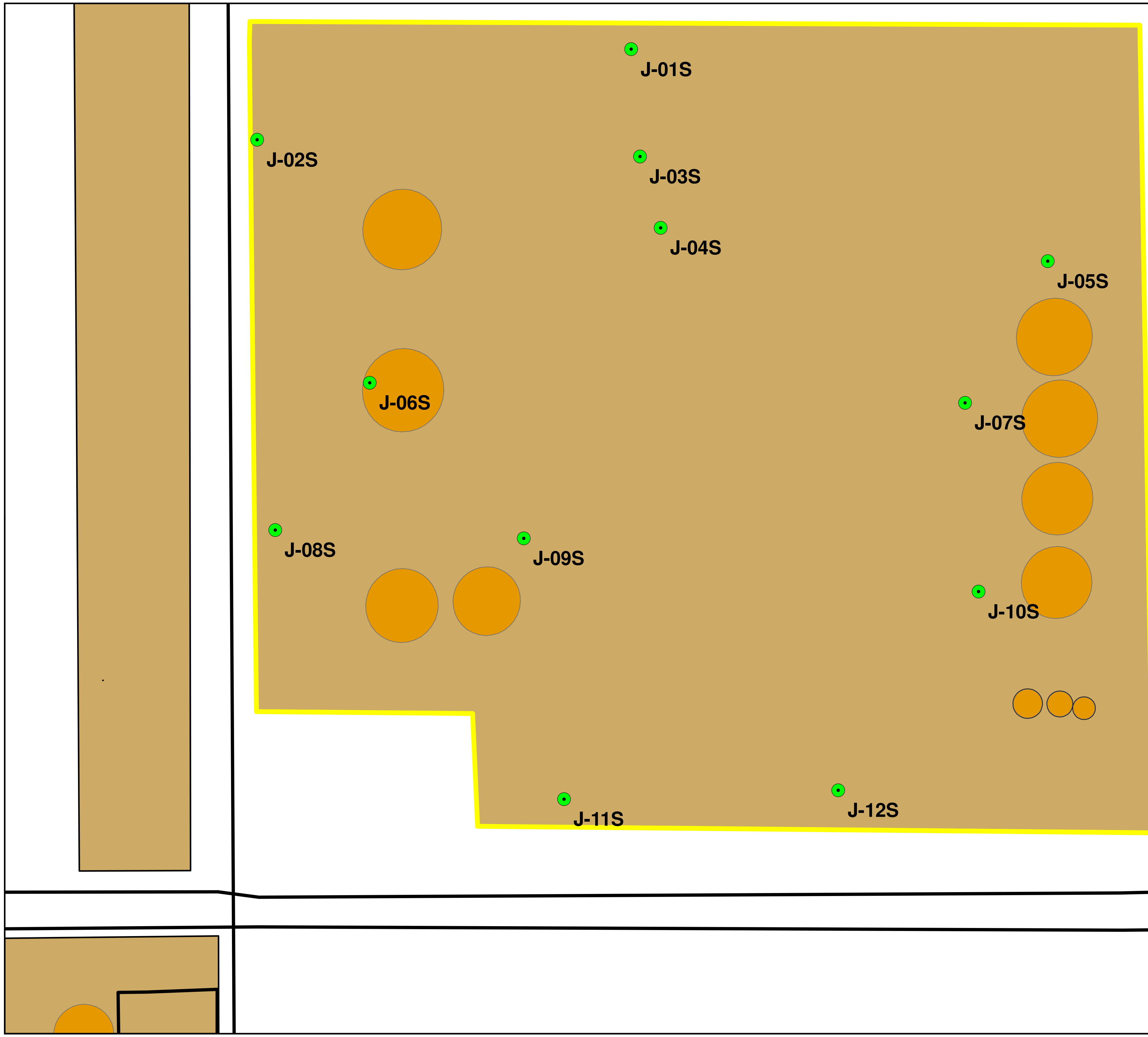
www.kleinfelder.com

FIGURE
2C



J-01 S FR-013	
1,2,3-Trichloropropane	0.0019 U
Methylene chloride	0.0038 J

J-02 S FR-016	
1,2,3-Trichloropropane	0.0015 U
Methylene chloride	0.0034 J

J-03 S FR-009A	
1,2,3-Trichloropropane	0.0018 U
Methylene chloride	0.00555 J

J-04 S FR-007	
1,2,3-Trichloropropane	0.0019 U
Methylene chloride	0.0134

J-05 S FR-033	
1,2,3-Trichloropropane	0.0017 U
Acetone	0.0963
Methylene chloride	0.0069 J

J-06 S FR-019A	
1,2,3-Trichloropropane	0.0016 U
Methylene chloride	0.0048 J

J-07 S FR-030	
1,2,3-Trichloropropane	0.0016 U
1,2,4-Trimethylbenzene	0.0025 J
Acetone	0.0099 J
Methylene chloride	0.0235
Toluene	0.0039 J
Xylene (total)	0.005 J

J-08 S FR-022	
1,2,3-Trichloropropane	0.0016 U
Acetone	0.0099 J
Methylene chloride	0.004 J

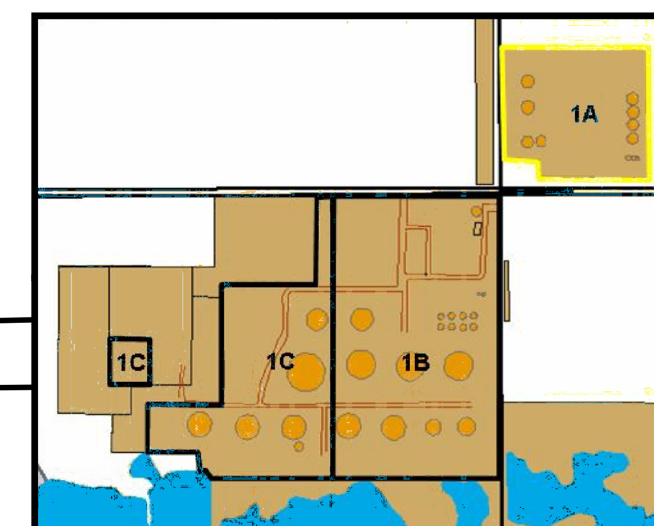
J-09 S FR-025	
1,2,3-Trichloropropane	0.0016 U
Methylene chloride	0.0043 J

J-10 S FR-027	
1,2,3-Trichloropropane	0.0016 U
1,2,4-Trimethylbenzene	0.0015 J
Methylene chloride	0.0035 J

J-11 S FR-001	
1,2,3-Trichloropropane	0.0018 U
Methylene chloride	0.0176

J-12 S FR-004	
1,2,3-Trichloropropane	0.0015 U
Acetone	0.0401 J
Methylene chloride	0.0117

Legend
- Soil Sample Points
- Roads
- AOC-1A
- Refinery Tanks
- AOCs



Notes:

1. Results are posted in mg/kg
2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

SDL Exceeds TCEQ Screening Level

0 50 100
Feet

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON/G.WITT	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-1A
Human Health
VOC Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

KLEINFELDER
Bright People. Right Solutions.
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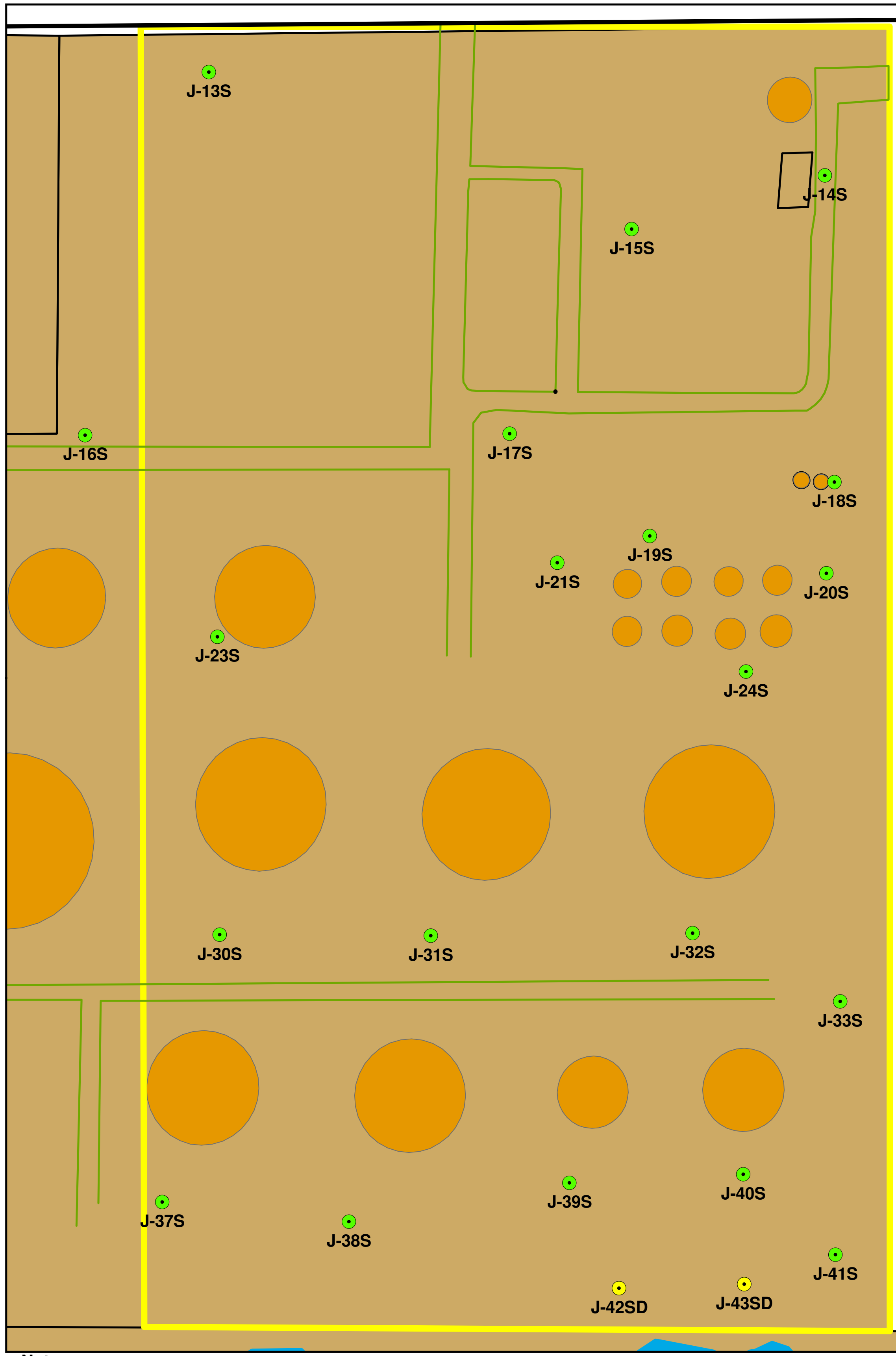
FIGURE
2D



J-14 S FR-061	
1,2,3-Trichloropropane	0.0017 U
Acetone	0.0121 J

J-15 S FR-035	
1,2,3-Trichloropropane	0.0017 U
Methylene chloride	0.0041 J

J-17 S FR-046	
1,2,3-Trichloropropane	0.0018 U
1,2,4-Trimethylbenzene	0.002 J
Methylene chloride	0.0048 J
Xylene (total)	0.0062 J

J-18 S FR-050	
1,2,3-Trichloropropane	0.0018 U
1,3,5-Trimethylbenzene	0.0018 J
Xylene (total)	0.0047 J

J-19 S FR-039A	
1,2,3-Trichloropropane	0.0018 U
Isopropylbenzene	0.02265
Methylene chloride	0.004 J
p-Isopropyltoluene	0.0015 J

J-20 S FR-044	
1,2,3-Trichloropropane	0.0016 U
1,2,4-Trimethylbenzene	0.0032 J
1,3,5-Trimethylbenzene	0.0023 J
Ethylbenzene	0.002 J
Isopropylbenzene	0.0014 J
Methylene chloride	0.0114
n-Propylbenzene	0.0014 J
Toluene	0.0044 J
Xylene (total)	0.0077 J

J-21 S FR-037	
1,2,3-Trichloropropane	0.0017 U
Methylene chloride	0.0096 J

J-23 S FR-054	
1,2,3-Trichloropropane	0.0016 U
Toluene	0.0014 J

J-30 S FR-094	
1,2,3-Trichloropropane	0.0020 U

J-31 S FR-099A	
1,2,3-Trichloropropane	0.0017 U
1,2,4-Trimethylbenzene	0.0015 J
Toluene	0.0015 J

J-32 S FR-096	
1,2,3-Trichloropropane	0.0018 U

J-33 S FR-105	
1,2,3-Trichloropropane	0.0017 U

J-37 S FR-119	
1,2,3-Trichloropropane	0.0016 U

J-38 S FR-116	
1,2,3-Trichloropropane	0.0015 U

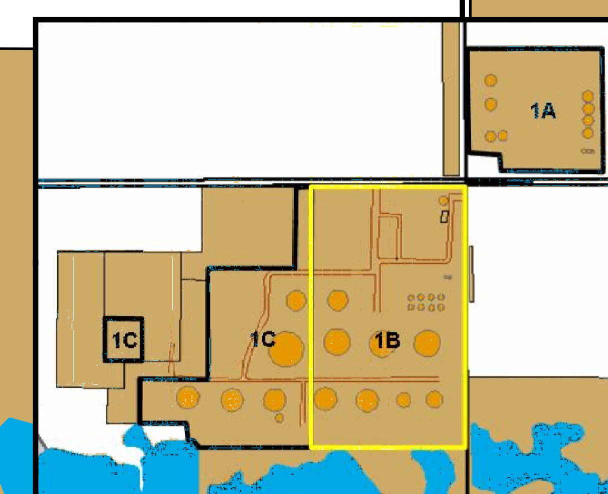
J-39 S FR-113	
1,2,3-Trichloropropane	0.0018 U

J-40 S FR-109	
1,2,3-Trichloropropane	0.0016 U

J-41 S FR-102	
1,2,3-Trichloropropane	0.0015 U

Legend

- Soil Sample Points
- Sediment Sample Points
- Roads
- Gravel/Dirt Road
- AOC-1B
- Refinery Tanks
- AOCs
- Wetland



Notes:

1. Results are posted in mg/kg
2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

SDL Exceeds TCEQ Screening Level

0 150 300
Feet

DATE DRAWN: 2/23/09	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1B
Human
VOC Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

KLEINFELDER
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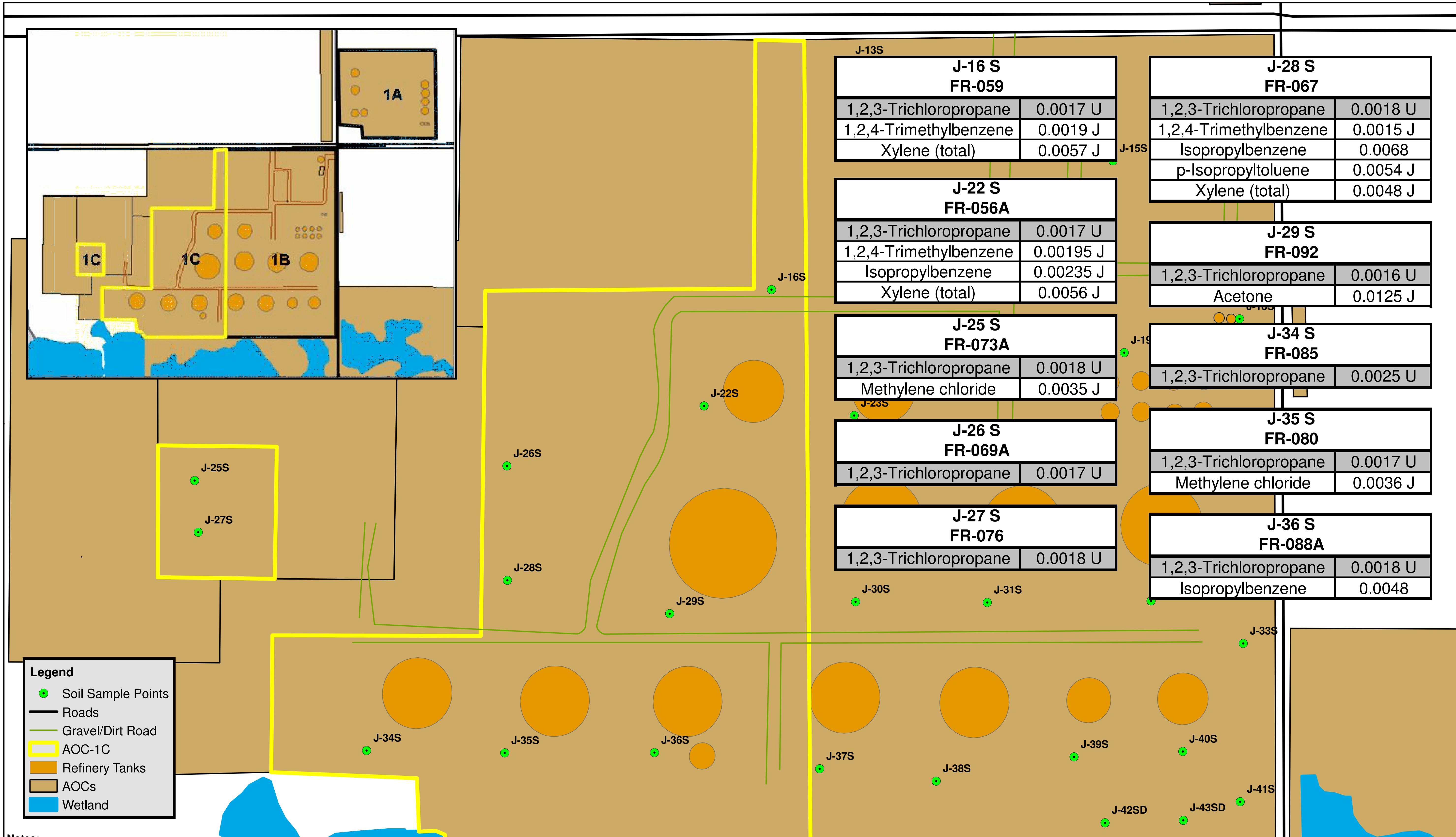
FIGURE
2E



J-16 S FR-059	
1,2,3-Trichloropropane	0.0017 U
1,2,4-Trimethylbenzene	0.0019 J
Xylene (total)	0.0057 J

J-22 S FR-056A	
1,2,3-Trichloropropane	0.0017 U
1,2,4-Trimethylbenzene	0.00195 J
Isopropylbenzene	0.00235 J
Xylene (total)	0.0056 J

J-25 S FR-073A	
1,2,3-Trichloropropane	0.0018 U
Methylene chloride	0.0035 J

J-26 S FR-069A	
1,2,3-Trichloropropane	0.0017 U

J-27 S FR-076	
1,2,3-Trichloropropane	0.0018 U

J-28 S FR-067	
1,2,3-Trichloropropane	0.0018 U
1,2,4-Trimethylbenzene	0.0015 J
Isopropylbenzene	0.0068
p-Isopropyltoluene	0.0054 J
Xylene (total)	0.0048 J

J-29 S FR-092	
1,2,3-Trichloropropane	0.0016 U
Acetone	0.0125 J

J-34 S FR-085	
1,2,3-Trichloropropane	0.0025 U

J-35 S FR-080	
1,2,3-Trichloropropane	0.0017 U
Methylene chloride	0.0036 J

J-36 S FR-088A	
1,2,3-Trichloropropane	0.0018 U
Isopropylbenzene	0.0048

Notes:

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J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

SDL Exceeds TCEQ Screening Level

N

0 100 200

Feet

DATE DRAWN:	DATE REVISED:
7/8/08	4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1C
Human Health
VOC Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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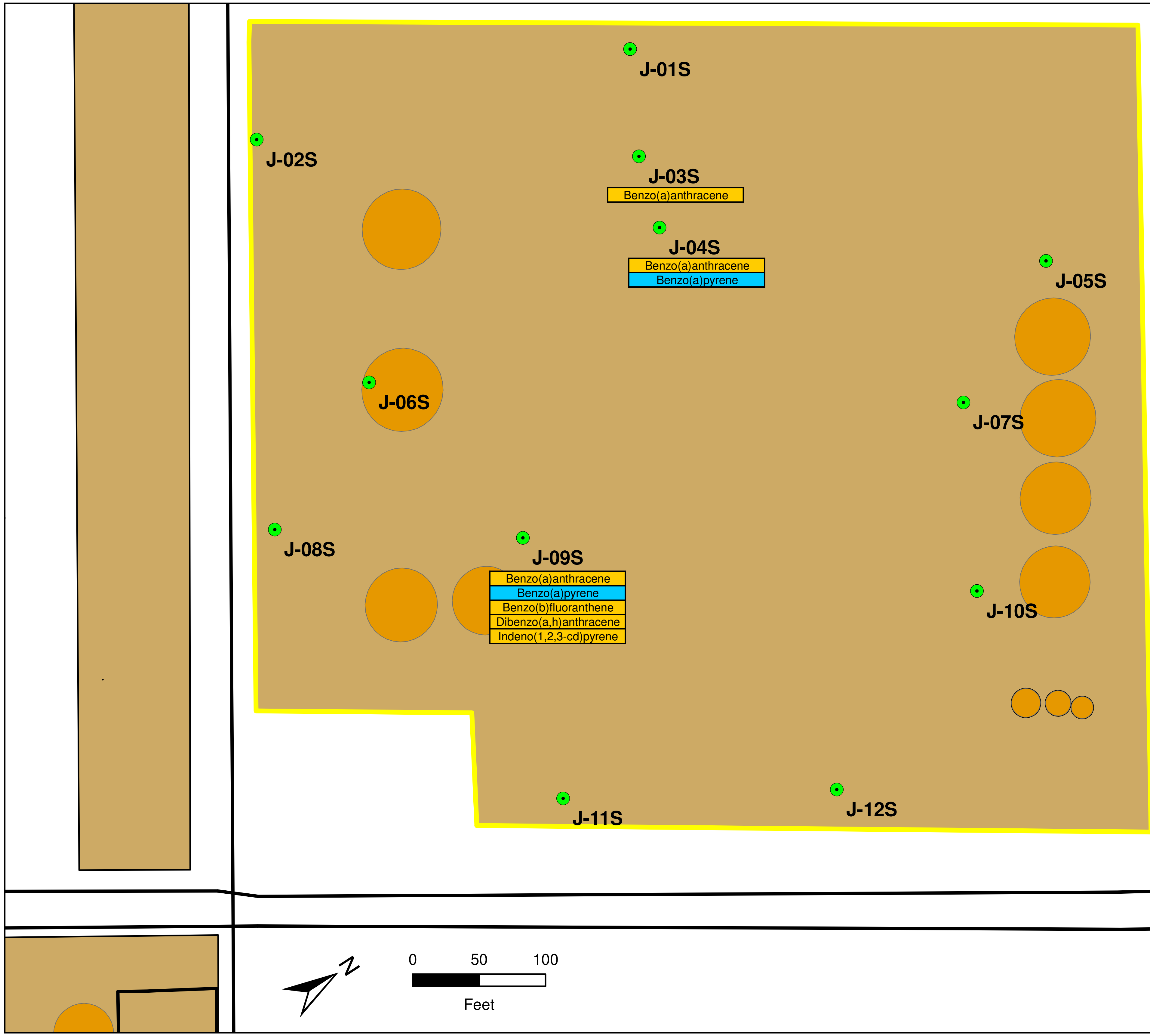
FIGURE

2F



J-01S FR-013	
7,12-Dimethylbenz(a)anthracene	0.23 U
Benzo(a)pyrene	0.074 U
Dibenzo(a,h)anthracene	0.079 U
N-Nitroso-di-n-propylamine	0.091 U
Quinoline	0.23 U

J-02S FR-016	
7,12-Dimethylbenz(a)anthracene	0.19 U
Benzo(a)pyrene	0.062 U
Dibenzo(a,h)anthracene	0.066 U
N-Nitroso-di-n-propylamine	0.076 U
Quinoline	0.19 U

J-03 S FR-009A	
4-Bromophenyl phenyl ether	0.32 U
4-Chlorophenyl phenyl ether	0.25 U
6-Methyl Chrysene	3.93
7,12-Dimethylbenz(a)anthracene	0.66 U
Anthracene	3.245
Benzenethiol	0.83 U
Benzo(a)anthracene	2.07
Benzo(a)pyrene	0.21 U
Benzo(b)fluoranthene	0.27 U
bis(2-Ethylhexyl)phthalate	0.3395 J
Carbazole	0.325 J
Chrysene	18.905
Dibenzo(a,h)anthracene	0.22 U
Fluorene	0.25 J
Indeno(1,2,3-cd)pyrene	0.25 U
N-Nitroso-di-n-propylamine	0.26 U
Phenanthrene	1.1935
Pyrene	0.3825 J
Quinoline	0.66 U

J-04 S FR-007	
4-Bromophenyl phenyl ether	0.84 U
4-Chlorophenyl phenyl ether	0.67 U
6-Methyl Chrysene	17.3
7,12-Dimethylbenz(a)anthracene	2.2 U
Anthracene	5.33
Benzenethiol	2.2 U
Benzo(a)anthracene	3.97
Benzo(a)pyrene	0.766 J
Benzo(b)fluoranthene	0.93 U
bis(2-Chloroethyl)ether	0.47 U
Chrysene	41.2
Dibenzo(a,h)anthracene	0.77 U
Hexachlorobenzene	0.72 U
Indeno(1,2,3-cd)pyrene	0.85 U
N-Nitroso-di-n-propylamine	0.88 U
Phenanthrene	2.06 J
Quinoline	2.2 U

J-05S FR-033	
7,12-Dimethylbenz(a)anthracene	0.21 U
Benzo(a)pyrene	0.070 U
Dibenzo(a,h)anthracene	0.074 U
N-Nitroso-di-n-propylamine	0.086 U
Quinoline	0.21 U

J-06S FR-019A	
7,12-Dimethylbenz(a)anthracene	0.22 U
Benzo(a)pyrene	0.066 U
Dibenzo(a,h)anthracene	0.079 U
N-Nitroso-di-n-propylamine	0.080 U
Quinoline	0.20 U

J-07S FR-030	
4-Bromophenyl phenyl ether	0.76 U
4-Chlorophenyl phenyl ether	0.61 U
7,12-Dimethylbenz(a)anthracene	2.0 U
Benzenethiol	2.0 U
Benzo(a)anthracene	0.74 U
Benzo(a)pyrene	0.65 U
Benzo(b)fluoranthene	0.84 U
bis(2-Chloroethyl)ether	0.42 U
Dibenzo(a,h)anthracene	0.69 U
Hexachlorobenzene	0.65 U
Indeno(1,2,3-cd)pyrene	0.77 U
N-Nitroso-di-n-propylamine	0.80 U
Quinoline	2.0 U

J-08S FR-022	
7,12-Dimethylbenz(a)anthracene	0.20 U
Benzo(a)pyrene	0.064 U
Dibenzo(a,h)anthracene	0.068 U
N-Nitroso-di-n-propylamine	0.079 U
Quinoline	0.20 U

J-09 S FR-025	
7,12-Dimethylbenz(a)anthracene	0.19 U
Anthracene	0.107 J
Benzo(a)anthracene	0.648
Benzo(a)pyrene	0.775
Benzo(b)fluoranthene	1.03
Benzo(g,h,i)perylene	0.629
Benzo(k)fluoranthene	0.326
Chrysene	0.773
Dibenzo(a,h)anthracene	0.281
Fluoranthene	1.42
Indeno(1,2,3-cd)pyrene	0.813
N-Nitroso-di-n-propylamine	0.078 U
Phenanthrene	0.679
Pyrene	1.58
Quinoline	0.19 U

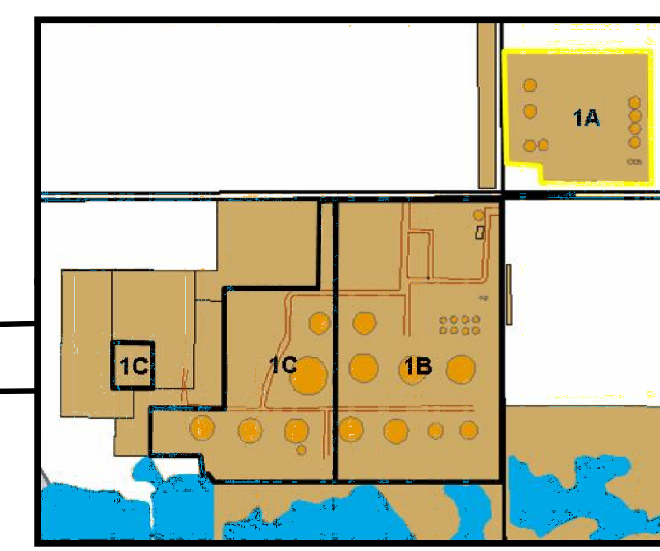
J-10S FR-027	
7,12-Dimethylbenz(a)anthracene	0.20 U
Benzo(a)pyrene	0.065 U
Dibenzo(a,h)anthracene	0.069 U
N-Nitroso-di-n-propylamine	0.080 U
Quinoline	0.20 U

J-11S FR-001	
7,12-Dimethylbenz(a)anthracene	0.22 U
Benzo(a)pyrene	0.072 U
Dibenzo(a,h)anthracene	0.077 U
N-Nitroso-di-n-propylamine	0.089 U
Quinoline	0.22 U

J-12 S FR-004	
7,12-Dimethylbenz(a)anthracene	0.19 U
Benzo(a)anthracene	0.121 J
Benzo(a)pyrene	0.172 J
Benzo(b)fluoranthene	0.218
Benzo(g,h,i)perylene	0.295
Chrysene	0.163 J
Dibenzo(a,h)anthracene	0.066 U
Fluoranthene	0.192
Indeno(1,2,3-cd)pyrene	0.192
N-Nitroso-di-n-propylamine	0.076 U
Pyrene	0.237
Quinoline	0.19 U

Legend

- Soil Sample Points
- Roads
- AOC-1A
- Refinery Tanks
- AOCs



Notes:

1. Results are posted in mg/kg
2. Qualifiers:
   U = Undetected at the sample detection limit (SDL)
   J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

- Exceeds EPA Region 6 MSSL
- Exceeds Both EPA and TCEQ Limit
- SDL Exceeds EPA Screening Level
- SDL Exceeds TCEQ Screening Level
- SDL Exceeds Both EPA and TCEQ Screening Level

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1A
Human Health
SVOC Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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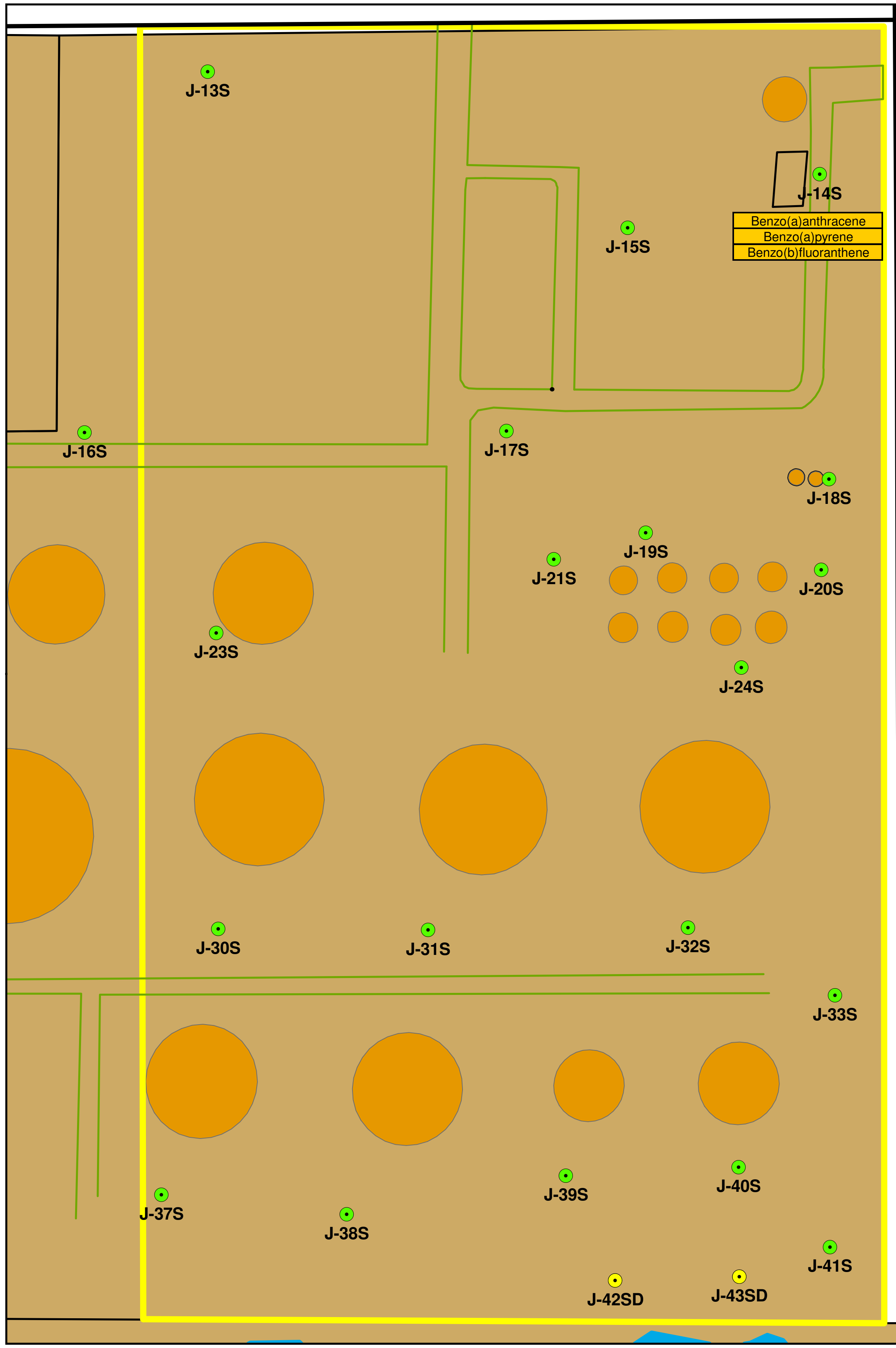
FIGURE
2G



J-14 S FR-061	
7,12-Dimethylbenz(a)anthracene	0.21 U
Benzo(a)anthracene	0.142 J
Benzo(a)pyrene	0.0985 J
Benzo(b)fluoranthene	0.181 J
bis(2-Ethylhexyl)phthalate	0.37
Chrysene	0.164 J
Dibenzo(a,h)anthracene	0.074 U
Fluoranthene	0.337
N-Nitroso-di-n-propylamine	0.085 U
Phenanthrene	0.147 J
Pyrene	0.336
Quinoline	0.21 U

J-15 S FR-035	
7,12-Dimethylbenz(a)anthracene	0.20 U
Benzo(a)pyrene	0.066 U
Dibenzo(a,h)anthracene	0.071 U
Naphthalene	0.175 J
N-Nitroso-di-n-propylamine	0.082 U
Quinoline	0.20 U

J-17S FR-046	
7,12-Dimethylbenz(a)anthracene	0.22 U
Benzo(a)pyrene	0.071 U
Dibenzo(a,h)anthracene	0.076 U
N-Nitroso-di-n-propylamine	0.087 U
Quinoline	0.22 U

J-18S FR-050	
7,12-Dimethylbenz(a)anthracene	0.21 U
Benzo(a)pyrene	0.068 U
Dibenzo(a,h)anthracene	0.073 U
N-Nitroso-di-n-propylamine	0.084 U
Quinoline	0.21 U

J-19S FR-039A	
4-Bromophenyl phenyl ether	0.82 U
4-Chlorophenyl phenyl ether	0.66 U
7,12-Dimethylbenz(a)anthracene	2.2 U
Benzenethiol	2.2 U
Benzo(a)anthracene	0.80 U
Benzo(a)pyrene	0.70 U
Benzo(b)fluoranthene	0.90 U
bis(2-Chloroethyl)ether	0.46 U
Dibenzo(a,h)anthracene	0.75 U
Hexachlorobenzene	0.70 U
Indeno(1,2,3-cd)pyrene	0.83 U
N-Nitroso-di-n-propylamine	0.86 U
Quinoline	2.2 U

J-20S FR-044	
4-Bromophenyl phenyl ether	0.73 U
4-Chlorophenyl phenyl ether	0.59 U
7,12-Dimethylbenz(a)anthracene	1.9 U
Benzenethiol	1.9 U
Benzo(a)anthracene	0.71 U
Benzo(a)pyrene	0.62 U
Benzo(b)fluoranthene	0.81 U
bis(2-Chloroethyl)ether	0.41 U
Dibenzo(a,h)anthracene	0.67 U
Hexachlorobenzene	0.63 U
Indeno(1,2,3-cd)pyrene	0.74 U
N-Nitroso-di-n-propylamine	0.77 U
Quinoline	1.9 U

J-21S FR-037	
4-Bromophenyl phenyl ether	0.80 U
4-Chlorophenyl phenyl ether	0.64 U
7,12-Dimethylbenz(a)anthracene	2.1 U
Benzenethiol	2.1 U
Benzo(a)anthracene	0.78 U
Benzo(a)pyrene	0.68 U
Benzo(b)fluoranthene	0.88 U
bis(2-Chloroethyl)ether	0.45 U
Dibenzo(a,h)anthracene	0.73 U
Hexachlorobenzene	0.68 U
Indeno(1,2,3-cd)pyrene	0.81 U
N-Nitroso-di-n-propylamine	0.84 U
Quinoline	2.1 U

J-23S FR-054	
7,12-Dimethylbenz(a)anthracene	0.19 U
Benzo(a)pyrene	0.063 U
Dibenzo(a,h)anthracene	0.068 U
N-Nitroso-di-n-propylamine	0.078 U
Quinoline	0.19 U

J-30S FR-094	
7,12-Dimethylbenz(a)anthracene	0.23 U
Benzo(a)pyrene	0.075 U
Dibenzo(a,h)anthracene	0.080 U
N-Nitroso-di-n-propylamine	0.092 U
Quinoline	0.23 U

J-31S FR-099A	
7,12-Dimethylbenz(a)anthracene	0.21 U
Benzo(a)pyrene	0.068 U
Dibenzo(a,h)anthracene	0.073 U
N-Nitroso-di-n-propylamine	0.084 U
Quinoline	0.21 U

J-32S FR-096	
7,12-Dimethylbenz(a)anthracene	0.23 U
Benzo(a)pyrene	0.074 U
Dibenzo(a,h)anthracene	0.079 U
N-Nitroso-di-n-propylamine	0.091 U
Quinoline	0.23 U

J-33 S FR-105	
7,12-Dimethylbenz(a)anthracene	0.20 U
Benzo(a)pyrene	0.065 U
Dibenzo(a,h)anthracene	0.069 U
Diethyl phthalate	0.0707 J
N-Nitroso-di-n-propylamine	0.080 U
Quinoline	0.20 U

J-37S FR-119	
7,12-Dimethylbenz(a)anthracene	0.19 U
Benzo(a)pyrene	0.063 U
Dibenzo(a,h)anthracene	0.068 U
N-Nitroso-di-n-propylamine	0.078 U
Quinoline	0.19 U

J-38S FR-116	
7,12-Dimethylbenz(a)anthracene	0.19 U
Benzo(a)pyrene	0.063 U
Dibenzo(a,h)anthracene	0.068 U
N-Nitroso-di-n-propylamine	0.078 U
Quinoline	0.19 U

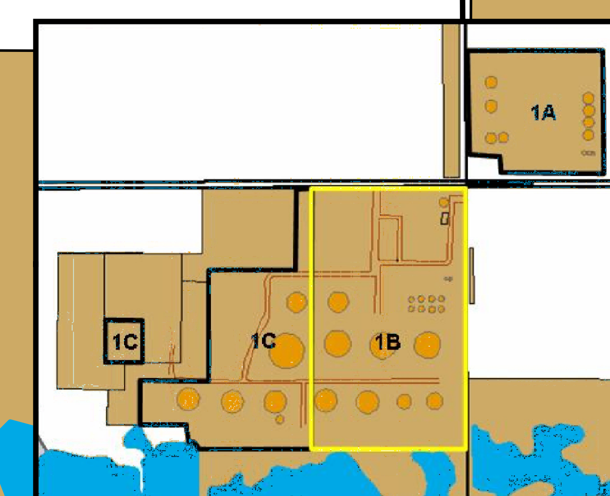
J-39S FR-113	
7,12-Dimethylbenz(a)anthracene	0.22 U
Benzo(a)pyrene	0.072 U
Dibenzo(a,h)anthracene	0.077 U
N-Nitroso-di-n-propylamine	0.088 U
Quinoline	0.22 U

J-40S FR-109	
7,12-Dimethylbenz(a)anthracene	0.20 U
Benzo(a)pyrene	0.067 U
Dibenzo(a,h)anthracene	0.071 U
N-Nitroso-di-n-propylamine	0.082 U
Quinoline	0.20 U

J-41S FR-102	
7,12-Dimethylbenz(a)anthracene	0.18 U
Benzo(a)pyrene	0.060 U
Dibenzo(a,h)anthracene	0.064 U
N-Nitroso-di-n-propylamine	0.074 U
Quinoline	0.18 U

Legend

- Soil Sample Points
- Sediment Sample Points
- Roads
- Gravel/Dirt Road
- AOC-1B
- Refinery Tanks
- AOCs
- Wetland



Notes:

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2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

- Exceeds EPA Region 6 MSSL
- SDL Exceeds EPA Screening Level
- SDL Exceeds TCEQ Screening Level
- SDL Exceeds Both EPA and TCEQ Screening Level

N

0 90 180

Feet

DATE DRAWN:	DATE REVISED:
2/23/09	4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1B
Human
SVOC Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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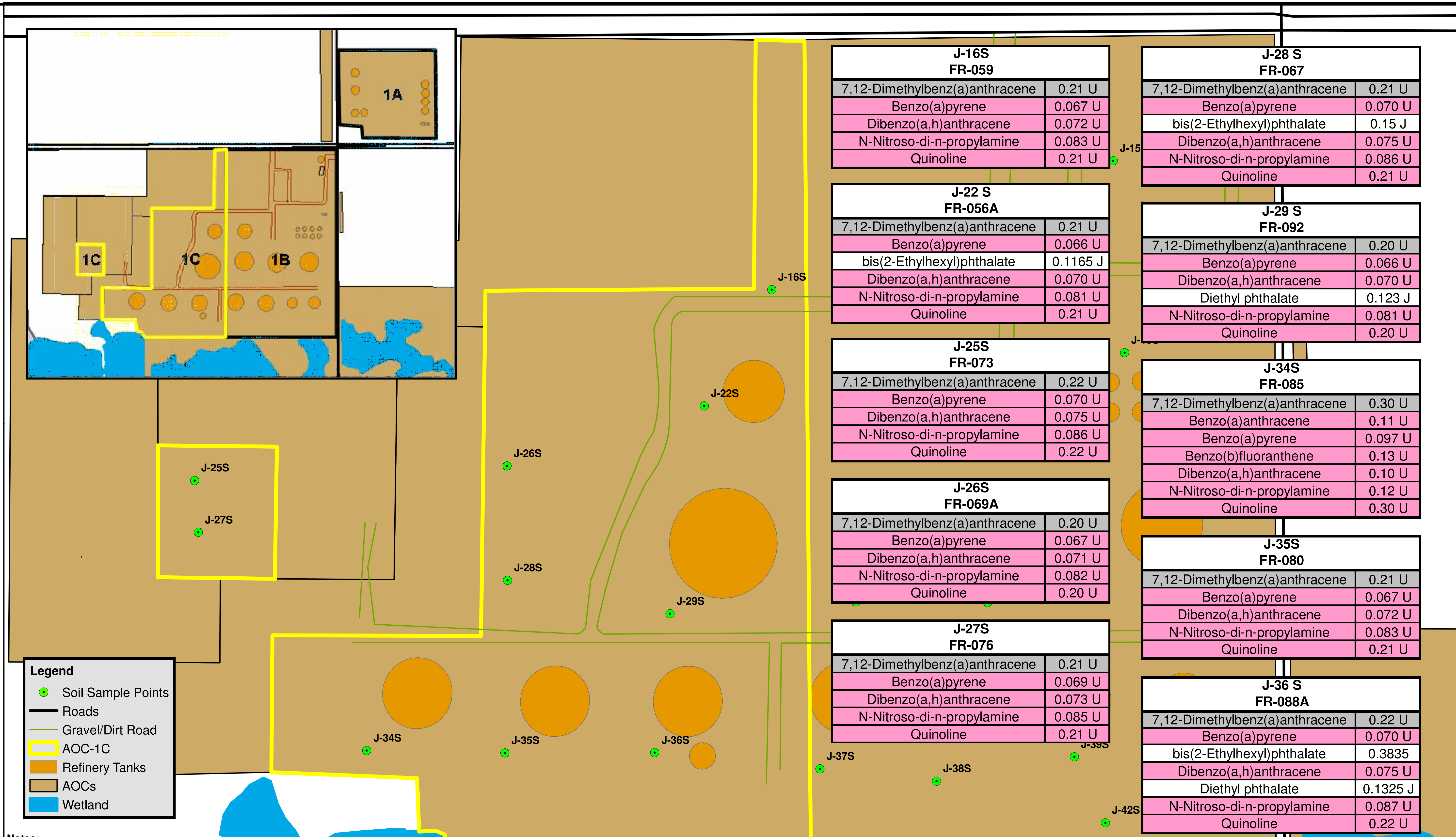
FIGURE
2H



J-16S FR-059	
7,12-Dimethylbenz(a)anthracene	0.21 U
Benzo(a)pyrene	0.067 U
Dibenzo(a,h)anthracene	0.072 U
N-Nitroso-di-n-propylamine	0.083 U
Quinoline	0.21 U

J-22 S FR-056A	
7,12-Dimethylbenz(a)anthracene	0.21 U
Benzo(a)pyrene	0.066 U
bis(2-Ethylhexyl)phthalate	0.1165 J
Dibenzo(a,h)anthracene	0.070 U
N-Nitroso-di-n-propylamine	0.081 U
Quinoline	0.21 U

J-25S FR-073	
7,12-Dimethylbenz(a)anthracene	0.22 U
Benzo(a)pyrene	0.070 U
Dibenzo(a,h)anthracene	0.075 U
N-Nitroso-di-n-propylamine	0.086 U
Quinoline	0.22 U

J-26S FR-069A	
7,12-Dimethylbenz(a)anthracene	0.20 U
Benzo(a)pyrene	0.067 U
Dibenzo(a,h)anthracene	0.071 U
N-Nitroso-di-n-propylamine	0.082 U
Quinoline	0.20 U

J-27S FR-076	
7,12-Dimethylbenz(a)anthracene	0.21 U
Benzo(a)pyrene	0.069 U
Dibenzo(a,h)anthracene	0.073 U
N-Nitroso-di-n-propylamine	0.085 U
Quinoline	0.21 U

J-28 S FR-067	
7,12-Dimethylbenz(a)anthracene	0.21 U
Benzo(a)pyrene	0.070 U
bis(2-Ethylhexyl)phthalate	0.15 J
Dibenzo(a,h)anthracene	0.075 U
N-Nitroso-di-n-propylamine	0.086 U
Quinoline	0.21 U

J-29 S FR-092	
7,12-Dimethylbenz(a)anthracene	0.20 U
Benzo(a)pyrene	0.066 U
Dibenzo(a,h)anthracene	0.070 U
Diethyl phthalate	0.123 J
N-Nitroso-di-n-propylamine	0.081 U
Quinoline	0.20 U

J-34S FR-085	
7,12-Dimethylbenz(a)anthracene	0.30 U
Benzo(a)anthracene	0.11 U
Benzo(a)pyrene	0.097 U
Benzo(b)fluoranthene	0.13 U
Dibenzo(a,h)anthracene	0.10 U
N-Nitroso-di-n-propylamine	0.12 U
Quinoline	0.30 U

J-35S FR-080	
7,12-Dimethylbenz(a)anthracene	0.21 U
Benzo(a)pyrene	0.067 U
Dibenzo(a,h)anthracene	0.072 U
N-Nitroso-di-n-propylamine	0.083 U
Quinoline	0.21 U

J-36 S FR-088A	
7,12-Dimethylbenz(a)anthracene	0.22 U
Benzo(a)pyrene	0.070 U
bis(2-Ethylhexyl)phthalate	0.3835
Dibenzo(a,h)anthracene	0.075 U
Diethyl phthalate	0.1325 J
N-Nitroso-di-n-propylamine	0.087 U
Quinoline	0.22 U

Notes:

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SDL Exceeds EPA Screening Level

SDL Exceeds TCEQ Screening Level

N

0 100 200

Feet

DATE DRAWN:	DATE REVISED:
7/8/08	4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1C
Human Health
SVOC Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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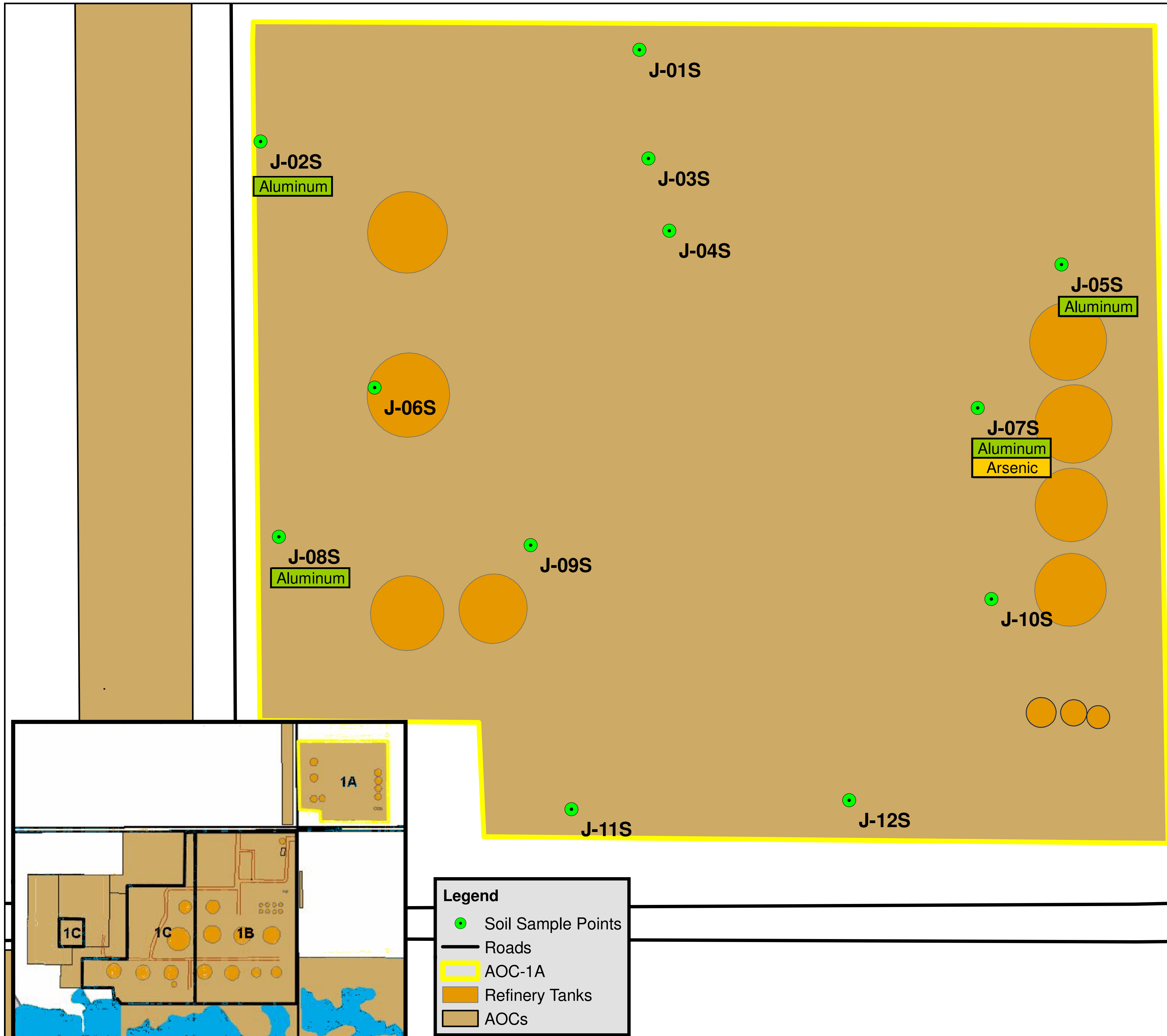
FIGURE
21



J-01 S FR-014	
Aluminum	1200
Barium	7.7 B
Chromium	0.63 B
Copper	0.59 B
Iron	235
Lead	1.9
Manganese	4.4
Mercury	0.055
Nickel	0.18 B
Vanadium	0.97 B
Zinc	1.6 B

J-02 S FR-017	
Aluminum	7690
Arsenic	0.34 B
Barium	31.1
Beryllium	0.15 B
Chromium	3.9
Cobalt	0.44 B
Copper	1.5 B
Iron	1900
Lead	3.8
Manganese	12.9
Mercury	0.019
Nickel	1.8 B
Vanadium	5
Zinc	7.3

J-03 S FR-011	
Aluminum	2250
Barium	11.8 B
Beryllium	0.035 B
Chromium	1.2
Copper	0.58 B
Iron	494
Lead	2.4
Manganese	5.1
Mercury	0.0051 B
Nickel	0.46 B
Vanadium	1.7 B
Zinc	2.2

J-04 S FR-008	
Aluminum	747
Barium	8.6 B
Chromium	2.1
Copper	0.79 B
Iron	363
Lead	2.3
Manganese	6.2
Nickel	0.32 B
Vanadium	1 B
Zinc	2.9

J-05 S FR-034	
Aluminum	959
Barium	8.5 B
Beryllium	0.042 B
Chromium	0.8
Copper	0.44 B
Iron	624
Lead	2.7
Manganese	4.6
Mercury	0.0021 B
Nickel	0.28 B
Vanadium	0.77 B
Zinc	3.6

J-06 S FR-021	
Aluminum	6880
Arsenic	0.23 B
Barium	23.1
Beryllium	0.13 B
Chromium	3.7
Cobalt	0.35 B
Copper	1.3 B
Iron	2000
Lead	3.2
Manganese	9.9
Mercury	0.033
Nickel	1.3 B
Vanadium	5.3
Zinc	7

J-07 S FR-031	
Aluminum	11400
Arsenic	0.47 B
Barium	52.4
Beryllium	0.28 B
Chromium	4.3
Cobalt	0.56 B
Copper	1.6 B
Iron	2680
Lead	4.3
Manganese	10.8
Mercury	0.012 B
Nickel	1.8 B
Vanadium	7.1
Zinc	10.3

J-08 S FR-023	
Aluminum	10900
Arsenic	0.29 B
Barium	29.3
Beryllium	0.25 B
Chromium	5.2
Cobalt	0.72 B
Copper	2
Iron	4410
Lead	4.1
Manganese	13.9
Mercury	0.048
Nickel	1.8 B
Vanadium	5.7
Zinc	15

J-09 S FR-026	
Aluminum	858
Barium	5.4 B
Beryllium	0.035 B
Chromium	1.8
Copper	0.48 B
Iron	341
Lead	1.5
Manganese	4.1
Nickel	0.22 B
Vanadium	0.95 B
Zinc	1.6 B

J-10 S FR-028	
Aluminum	1090
Barium	6.7 B
Beryllium	0.047 B
Chromium	1
Copper	0.35 B
Iron	258
Lead	1.7
Manganese	3.1
Nickel	0.21 B
Vanadium	0.83 B
Zinc	3.1

J-11 S FR-002	
Aluminum	1110
Arsenic	0.26 B
Barium	10.2 B
Beryllium	0.1 B
Chromium	0.98 B
Copper	0.49 B
Iron	224
Lead	2.3
Manganese	3.5
Mercury	0.0017 B
Nickel	0.26 B
Vanadium	0.89 B
Zinc	1.5 B

J-12 S FR-005	
Aluminum	748
Barium	4.2 B
Chromium	0.58 B
Copper	0.47 B
Iron	174
Lead	1.3
Manganese	2.7
Mercury	0.59
Selenium	0.22 B
Vanadium	0.65 B
Zinc	1.5 B

Notes:

1. Results are posted in mg/kg

2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds EPA Region 6 MSSL

Exceeds TCEQ Tier 1 Residential PCL

0 50 100

Feet

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1A
Human Health
Metal Subsurface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 | FILE NAME: Falcon Refinery Base Map

KLEINFELDER
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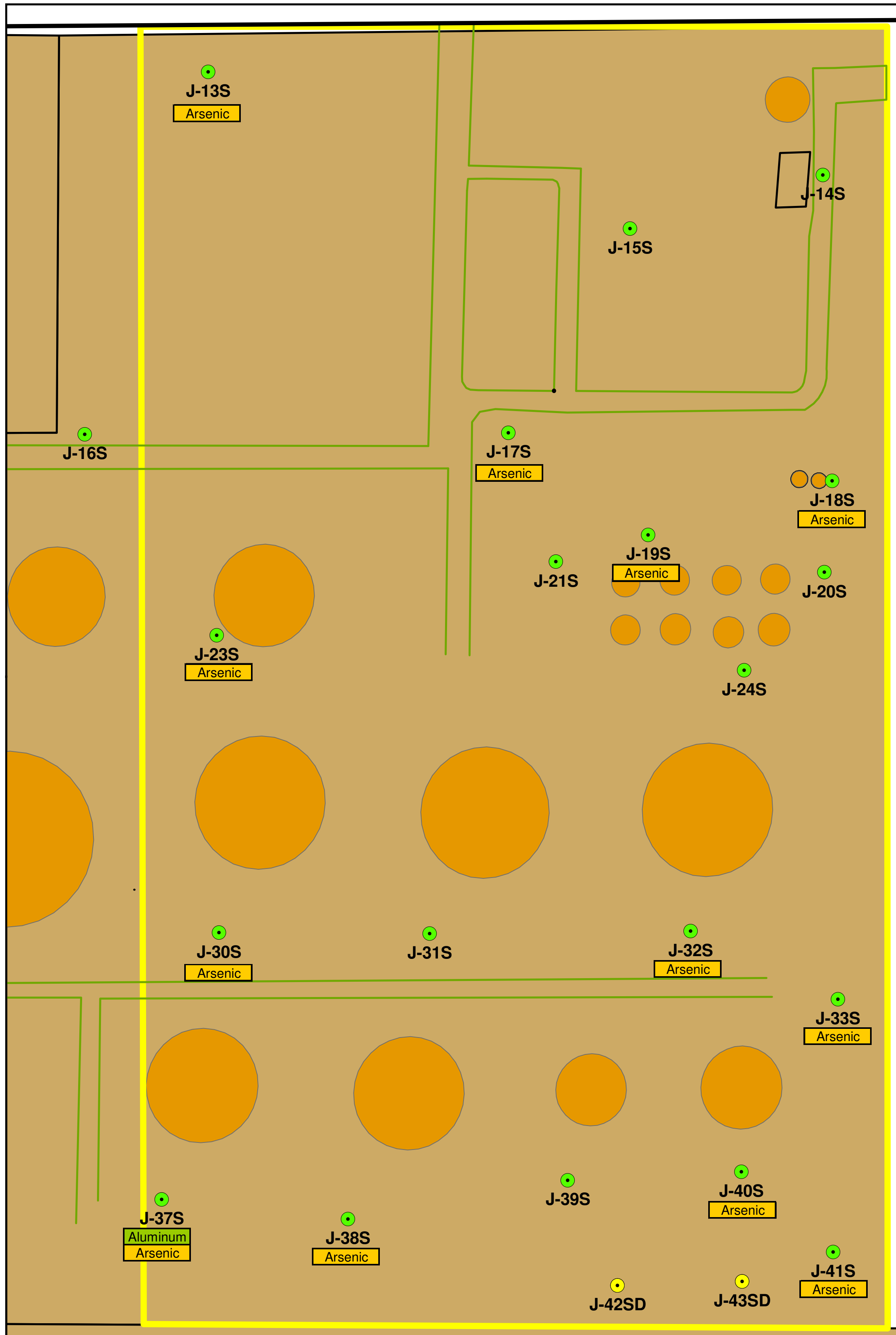
Phone: 512-926-6650 Fax: 512-833-5058
www.kleinfelder.com

FIGURE
3A



J-13 S FR-065	
Aluminum	5140
Arsenic	0.54 B
Barium	25.2
Beryllium	0.19 B
Chromium	4.9
Cobalt	1.1 B
Copper	1.9 B
Iron	2910
Lead	2.8
Manganese	17.2
Mercury	0.0073 B
Nickel	5.8
Vanadium	6.9
Zinc	11

J-14 S FR-062	
Aluminum	917
Barium	7.4 B
Chromium	0.6 B
Hex Chrom	1.3 B
Copper	0.39 B
Iron	270
Lead	1.8
Manganese	5.5
Selenium	0.36 B
Vanadium	1.3 B
Zinc	2.1 B

J-15 S FR-036	
Aluminum	5880
Arsenic	0.38 B
Barium	26.5
Beryllium	0.32 B
Chromium	3.4
Cobalt	0.58 B
Copper	3.8
Iron	2220
Lead	3.5
Manganese	11.9
Mercury	0.013 B
Nickel	1.5 B
Vanadium	4.4 B
Zinc	8.1

J-17 S FR-047	
Aluminum	1130
Arsenic	0.41 B
Barium	11.4 B
Chromium	2.4
Cobalt	0.24 B
Copper	0.45 B
Iron	1230
Lead	2.3
Manganese	9.9
Mercury	0.055
Nickel	0.29 B
Vanadium	2.1 B
Zinc	2.3 B

J-18 S FR-051	
Aluminum	3510
Arsenic	0.44 B
Barium	21.5 B
Beryllium	0.086 B
Chromium	3.2
Hex Chrom	1.6 B
Cobalt	0.25 B
Copper	0.89 B
Iron	1270
Lead	4.2
Manganese	10.1
Mercury	0.0048 B
Nickel	0.36 B
Vanadium	3.6 B
Zinc	4.4

J-19 S FR-041	
Aluminum	1760
Arsenic	1.7
Barium	98.7
Beryllium	0.13 B
Chromium	15
Cobalt	0.69 B
Copper	5.9
Iron	3080
Lead	26
Manganese	19.7
Mercury	0.0065 B
Nickel	5.9
Vanadium	3.2 B
Zinc	18.9

J-20 S FR-045	
Aluminum	915
Barium	11.5 B
Chromium	2.5
Copper	0.62 B
Iron	548
Lead	2.1
Manganese	7.5
Nickel	0.22 B
Vanadium	1.8 B
Zinc	3.2

J-21 S FR-038	
Aluminum	648
Barium	4.6 B
Beryllium	0.054 B
Chromium	0.59 B
Hex Chrom	1.2 B
Copper	0.39 B
Iron	381
Lead	1.5
Manganese	4.5
Vanadium	1.1 B
Zinc	4.4

J-23 S FR-055	
Aluminum	4180
Arsenic	1.4
Barium	41.8
Beryllium	0.1 B
Chromium	3.5
Cobalt	1.2 B
Copper	2.4 B
Iron	2590
Lead	3.6
Manganese	130
Mercury	0.0077 B
Nickel	2.6 B
Vanadium	6.7
Zinc	11

J-24 S FR-043	
Aluminum	790
Arsenic	0.3 B
Barium	12 B
Beryllium	0.064 B
Chromium	1.2
Copper	0.9 B
Iron	529
Lead	3.1
Manganese	9.1
Mercury	0.012 B
Nickel	0.23 B
Vanadium	1.2 B
Zinc	5.7

J-30 S FR-095	
Aluminum	1770
Arsenic	0.54 B
Barium	25.1
Beryllium	0.11 B
Chromium	2.2
Cobalt	0.56 B
Copper	1.1 B
Iron	1130
Lead	2.7
Manganese	69.5
Mercury	0.0043 B
Nickel	1 B
Vanadium	2.4 B
Zinc	7

J-31 S FR-101	
Aluminum	1390
Arsenic	0.23 B
Barium	13.5 B
Beryllium	0.023 B
Chromium	0.76 B
Cobalt	0.31 B
Copper	1.2 B
Iron	693
Lead	1.7
Manganese	9
Mercury	0.0026 B
Nickel	0.26 B
Vanadium	1.7 B
Zinc	8.3

J-32 S FR-097	
Aluminum	2460
Arsenic	1.1
Barium	39.6
Beryllium	0.12 B
Chromium	2.9
Cobalt	0.55 B
Copper	1.1 B
Iron	1790
Lead	2.7
Manganese	29
Nickel	1.3 B
Vanadium	3.7 B
Zinc	6.4

J-33 S FR-106	
Aluminum	1240
Arsenic	0.81 B
Barium	36.2
Beryllium	0.044 B
Chromium	1.9
Cobalt	0.84 B
Copper	1 B
Iron	1400
Lead	5.9
Manganese	73
Mercury	0.0048 B
Nickel	0.36 B
Vanadium	2 B
Zinc	2.8

J-37 S FR-120	
Aluminum	8450
Arsenic	2.1
Barium	97.8
Beryllium	0.29 B
Chromium	8.8
Cobalt	1.5 B
Copper	4.4
Iron	5250
Lead	6
Manganese	112
Nickel	2.9 B
Vanadium	12.1
Zinc	16.6

J-38 S FR-117	
Aluminum	3310
Arsenic	2.2
Barium	25
Beryllium	0.11 B
Chromium	2.5
Cobalt	0.58 B
Copper	1.9 B
Iron	1930
Lead	5.7
Manganese	153
Mercury	0.0013 B
Nickel	1.4 B
Vanadium	5.8
Zinc	7.2

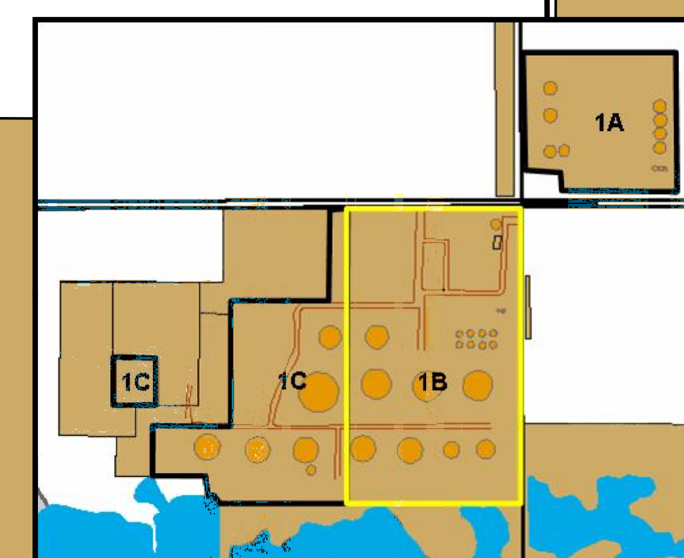
J-39 S FR-114	
Aluminum	1160
Arsenic	0.7 B
Barium	16.3 B
Beryllium	0.041 B
Chromium	1.4
Cobalt	0.26 B
Copper	0.61 B
Iron	954
Lead	1.6
Manganese	76.3
Mercury	0.014 B
Nickel	0.39 B
Vanadium	2.4 B
Zinc	2.3

J-40 S FR-110A	
Aluminum	1495
Arsenic	0.62 B
Barium	59.65
Beryllium	0.0445 B
Chromium	2.3
Cobalt	0.715 B
Copper	0.725 B
Iron	1350
Lead	2.15
Manganese	70.05
Mercury	0.0046 B
Nickel	0.66 B
Vanadium	1.95 B
Zinc	3.1

J-41 S FR-103	
Aluminum	2480
Arsenic	1.7
Barium	26.4
Beryllium	0.067 B
Chromium	2.2
Cobalt	0.78 B
Copper	1.9 B
Iron	1780
Lead	6.3
Manganese	134
Mercury	0.0053 B
Nickel	0.99 B
Vanadium	4.3 B
Zinc	6.7

Legend

- Soil Sample Points
- Sediment Sample Points
- Roads
- Gravel/Dirt Road
- AOC-1B
- Refinery Tanks
- AOCs
- Wetland



Notes:

1. Results are posted in mg/kg
   Hex Chrom posted in mg/l

2. Qualifiers:

   B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds EPA Region 6 MSSL

Exceeds TCEQ Tier 1 Residential PCL

0 90 180

Feet

DATE DRAWN:	DATE REVISED:
4/30/08	4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1B
Human Health
Metal Subsurface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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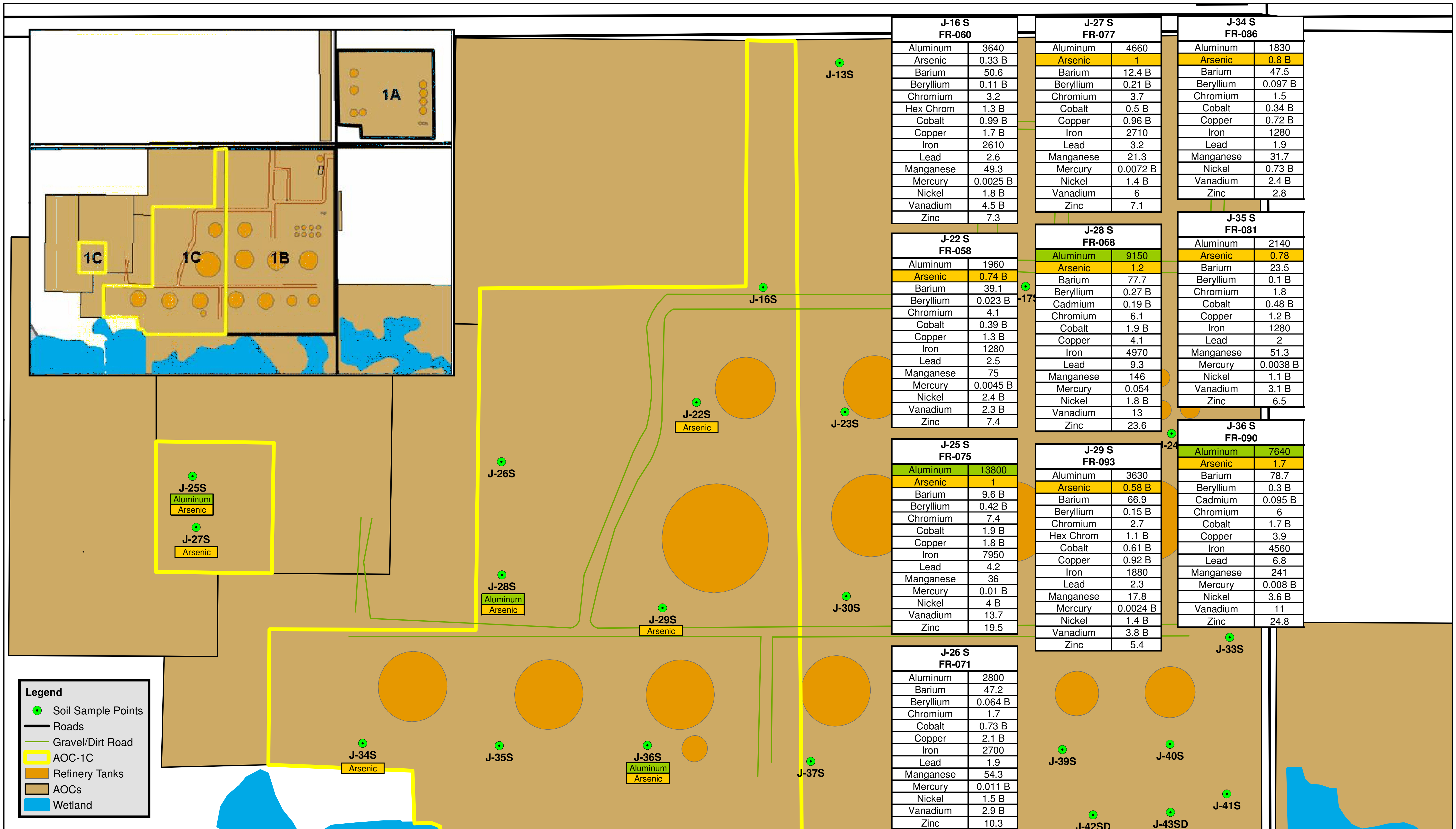
www.kleinfelder.com

FIGURE

3B



J-16 S FR-060	
Aluminum	3640
Arsenic	0.33 B
Barium	50.6
Beryllium	0.11 B
Chromium	3.2
Hex Chrom	1.3 B
Cobalt	0.99 B
Copper	1.7 B
Iron	2610
Lead	2.6
Manganese	49.3
Mercury	0.0025 B
Nickel	1.8 B
Vanadium	4.5 B
Zinc	7.3

J-22 S FR-058	
Aluminum	1960
Arsenic	0.74 B
Barium	39.1
Beryllium	0.023 B
Chromium	4.1
Cobalt	0.39 B
Copper	1.3 B
Iron	1280
Lead	2.5
Manganese	75
Mercury	0.0045 B
Nickel	2.4 B
Vanadium	2.3 B
Zinc	7.4

J-25 S FR-075	
Aluminum	13800
Arsenic	1
Barium	9.6 B
Beryllium	0.42 B
Chromium	7.4
Cobalt	1.9 B
Copper	1.8 B
Iron	7950
Lead	4.2
Manganese	36
Mercury	0.01 B
Nickel	4 B
Vanadium	13.7
Zinc	19.5

J-26 S FR-071	
Aluminum	2800
Barium	47.2
Beryllium	0.064 B
Chromium	1.7
Cobalt	0.73 B
Copper	2.1 B
Iron	2700
Lead	1.9
Manganese	54.3
Mercury	0.011 B
Nickel	1.5 B
Vanadium	2.9 B
Zinc	10.3

J-27 S FR-077	
Aluminum	4660
Arsenic	1
Barium	12.4 B
Beryllium	0.21 B
Chromium	3.7
Cobalt	0.5 B
Copper	0.96 B
Iron	2710
Lead	3.2
Manganese	21.3
Mercury	0.0072 B
Nickel	1.4 B
Vanadium	6
Zinc	7.1

J-28 S FR-068	
Aluminum	9150
Arsenic	1.2
Barium	77.7
Beryllium	0.27 B
Cadmium	0.19 B
Chromium	6.1
Cobalt	1.9 B
Copper	4.1
Iron	4970
Lead	9.3
Manganese	146
Mercury	0.054
Nickel	1.8 B
Vanadium	13
Zinc	23.6

J-29 S FR-093	
Aluminum	3630
Arsenic	0.58 B
Barium	66.9
Beryllium	0.15 B
Chromium	2.7
Hex Chrom	1.1 B
Cobalt	0.61 B
Copper	0.92 B
Iron	1880
Lead	2.3
Manganese	17.8
Mercury	0.0024 B
Nickel	1.4 B
Vanadium	3.8 B
Zinc	5.4

J-34 S FR-086	
Aluminum	1830
Arsenic	0.8 B
Barium	47.5
Beryllium	0.097 B
Chromium	1.5
Cobalt	0.34 B
Copper	0.72 B
Iron	1280
Lead	1.9
Manganese	31.7
Nickel	0.73 B
Vanadium	2.4 B
Zinc	2.8

J-35 S FR-081	
Aluminum	2140
Arsenic	0.78
Barium	23.5
Beryllium	0.1 B
Chromium	1.8
Cobalt	0.48 B
Copper	1.2 B
Iron	1280
Lead	2
Manganese	51.3
Mercury	0.0038 B
Nickel	1.1 B
Vanadium	3.1 B
Zinc	6.5

J-36 S FR-090	
Aluminum	7640
Arsenic	1.7
Barium	78.7
Beryllium	0.3 B
Cadmium	0.095 B
Chromium	6
Cobalt	1.7 B
Copper	3.9
Iron	4560
Lead	6.8
Manganese	241
Mercury	0.008 B
Nickel	3.6 B
Vanadium	11
Zinc	24.8

Notes:

1. Results are posted in mg/kg
   Hex Chrom posted in mg/l

2. Qualifiers:

   B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds EPA Region 6 MSSL

Exceeds TCEQ Tier 1 Residential PCL

N

0 100 200

Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1C
Human Health
Metal Subsurface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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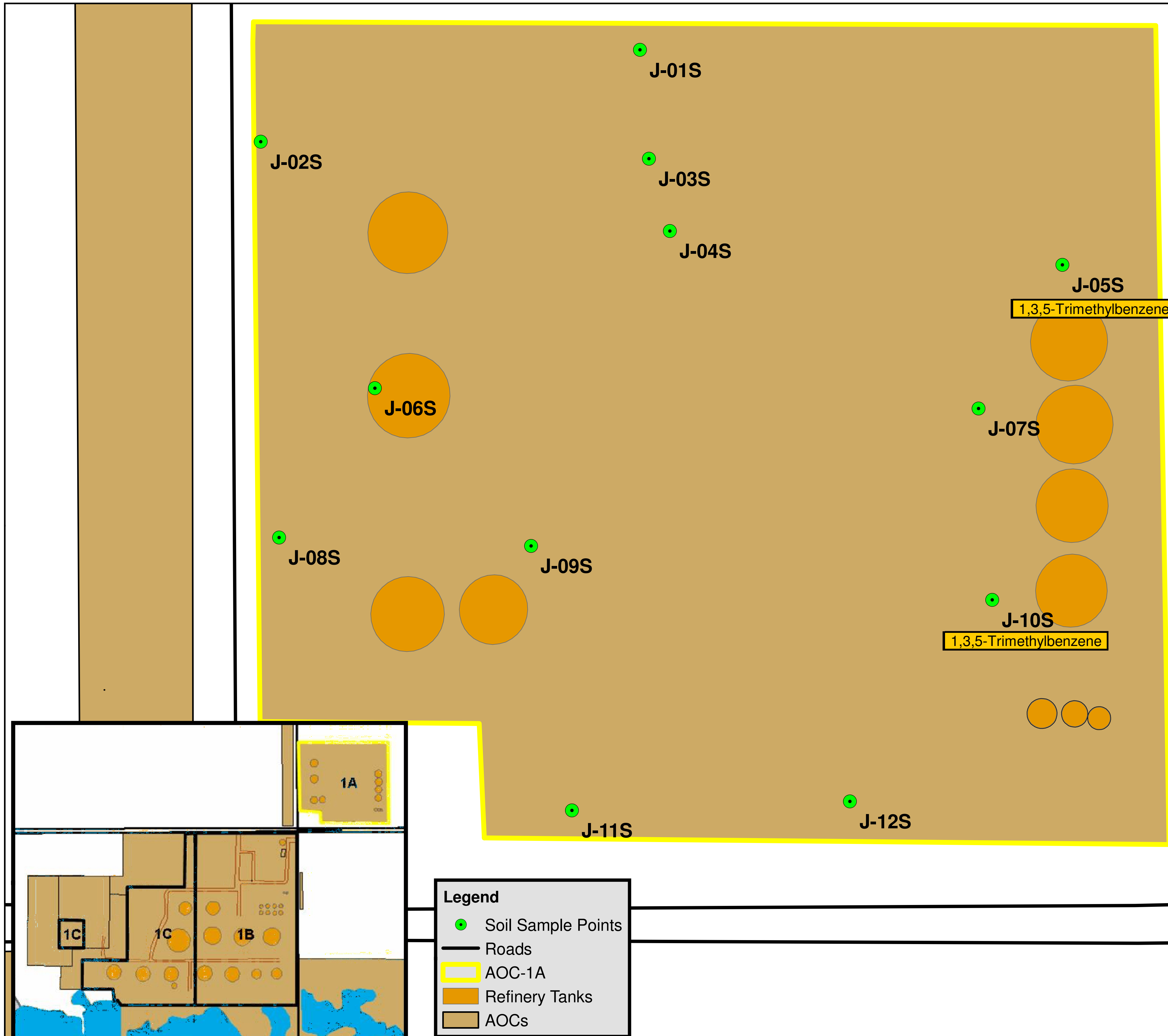
FIGURE
3C



J-01 S FR-014	
1,2,3-Trichloropropane	0.0019 U
Acetone	0.0155 J
Cyclohexane	0.0054 J
Methylene chloride	0.0078 J

J-02 S FR-017	
1,2,3-Trichloropropane	0.0016 U
Acetone	0.0234 J
Methylene chloride	0.0039 J

J-03 S FR-011	
1,2,3-Trichloropropane	0.0018 U
Acetone	0.027 J
Methylene chloride	0.0072 J

J-04 S FR-008	
1,2,3-Trichloropropane	0.0018 U
Ethylbenzene	0.0026 J
Methylene chloride	0.0101 J
Xylene (total)	0.0064 J

J-05 S FR-034	
1,2,3-Trichloropropane	0.0017 U
1,2,4-Trimethylbenzene	0.0796
1,3,5-Trimethylbenzene	0.0175
Acetone	0.0697
Ethylbenzene	0.0275
Isopropylbenzene	0.0109
Methylene chloride	0.016
n-Butylbenzene	0.0149
n-Propylbenzene	0.0085
p-Isopropyltoluene	0.0032 J
Toluene	0.002 J
Xylene (total)	0.0217

J-06 S FR-021	
1,2,3-Trichloropropane	0.0015 U
1,3,5-Trimethylbenzene	0.0051 J
Acetone	0.109
Methylene chloride	0.0048 J

J-07 S FR-031	
1,2,3-Trichloropropane	0.0016 U
Acetone	0.0324 J
Methylene chloride	0.0143

J-08 S FR-023	
1,2,3-Trichloropropane	0.0016 U
Acetone	0.249

J-09 S FR-026	
1,2,3-Trichloropropane	0.0016 U
Acetone	0.0163 J
Methylene chloride	0.0042 J

J-10 S FR-028	
1,2,3-Trichloropropane	0.0016 U
1,2,4-Trimethylbenzene	0.14
1,3,5-Trimethylbenzene	0.0667
Acetone	0.035 J
Ethylbenzene	0.0061
Isopropylbenzene	0.007
Methylene chloride	0.0076 J
n-Butylbenzene	0.0799
p-Isopropyltoluene	0.108
tert-Butylbenzene	0.152
Toluene	0.0035 J
Xylene (total)	0.0119 J

J-11 S FR-002	
1,2,3-Trichloropropane	0.0018 U
Methylene chloride	0.0146

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

Exceeds EPA Region 6 MSSL

SDL Exceeds TCEQ Screening Level

0 50 100

Feet

DATE DRAWN:	DATE REVISED:
4/30/08	4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1A Human Health VOC Subsurface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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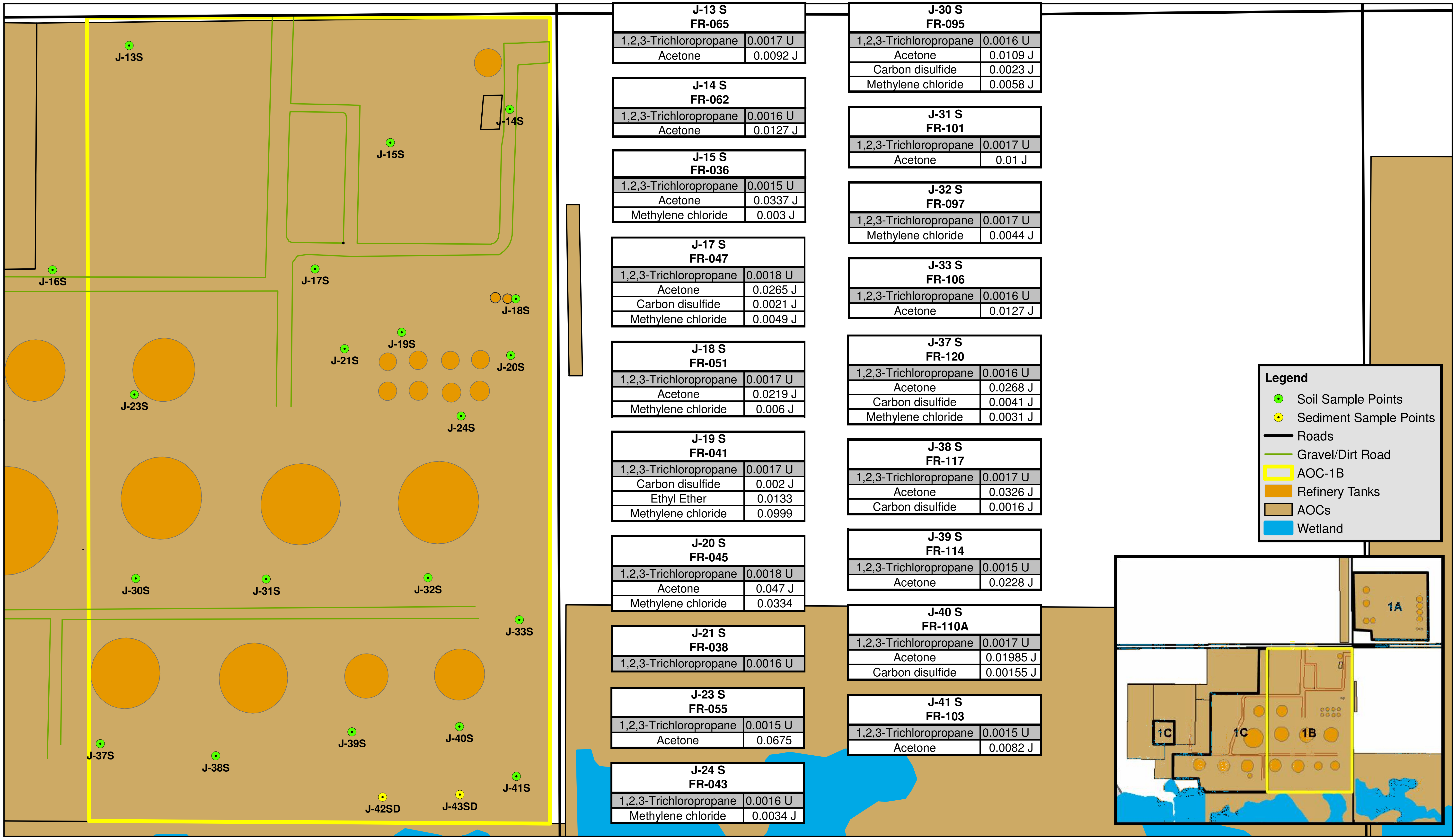
FIGURE
3D



J-13 S FR-065	
1,2,3-Trichloropropane	0.0017 U
Acetone	0.0092 J

J-14 S FR-062	
1,2,3-Trichloropropane	0.0016 U
Acetone	0.0127 J

J-15 S FR-036	
1,2,3-Trichloropropane	0.0015 U
Acetone	0.0337 J
Methylene chloride	0.003 J

J-17 S FR-047	
1,2,3-Trichloropropane	0.0018 U
Acetone	0.0265 J
Carbon disulfide	0.0021 J
Methylene chloride	0.0049 J

J-18 S FR-051	
1,2,3-Trichloropropane	0.0017 U
Acetone	0.0219 J
Methylene chloride	0.006 J

J-19 S FR-041	
1,2,3-Trichloropropane	0.0017 U
Carbon disulfide	0.002 J
Ethyl Ether	0.0133
Methylene chloride	0.0999

J-20 S FR-045	
1,2,3-Trichloropropane	0.0018 U
Acetone	0.047 J
Methylene chloride	0.0334

J-21 S FR-038	
1,2,3-Trichloropropane	0.0016 U

J-23 S FR-055	
1,2,3-Trichloropropane	0.0015 U
Acetone	0.0675

J-24 S FR-043	
1,2,3-Trichloropropane	0.0016 U
Methylene chloride	0.0034 J

J-30 S FR-095	
1,2,3-Trichloropropane	0.0016 U
Acetone	0.0109 J
Carbon disulfide	0.0023 J
Methylene chloride	0.0058 J

J-31 S FR-101	
1,2,3-Trichloropropane	0.0017 U
Acetone	0.01 J

J-32 S FR-097	
1,2,3-Trichloropropane	0.0017 U
Methylene chloride	0.0044 J

J-33 S FR-106	
1,2,3-Trichloropropane	0.0016 U
Acetone	0.0127 J

J-37 S FR-120	
1,2,3-Trichloropropane	0.0016 U
Acetone	0.0268 J
Carbon disulfide	0.0041 J
Methylene chloride	0.0031 J

J-38 S FR-117	
1,2,3-Trichloropropane	0.0017 U
Acetone	0.0326 J
Carbon disulfide	0.0016 J

J-39 S FR-114	
1,2,3-Trichloropropane	0.0015 U
Acetone	0.0228 J

J-40 S FR-110A	
1,2,3-Trichloropropane	0.0017 U
Acetone	0.01985 J
Carbon disulfide	0.00155 J

J-41 S FR-103	
1,2,3-Trichloropropane	0.0015 U
Acetone	0.0082 J

Notes:

1. Results are posted in mg/kg
2. Qualifiers:
   - U = Undetected at the sample detection limit (SDL)
   - J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

SDL Exceeds TCEQ Screening Level

N

0 100 200

Feet

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1B
Human Health
VOC Subsurface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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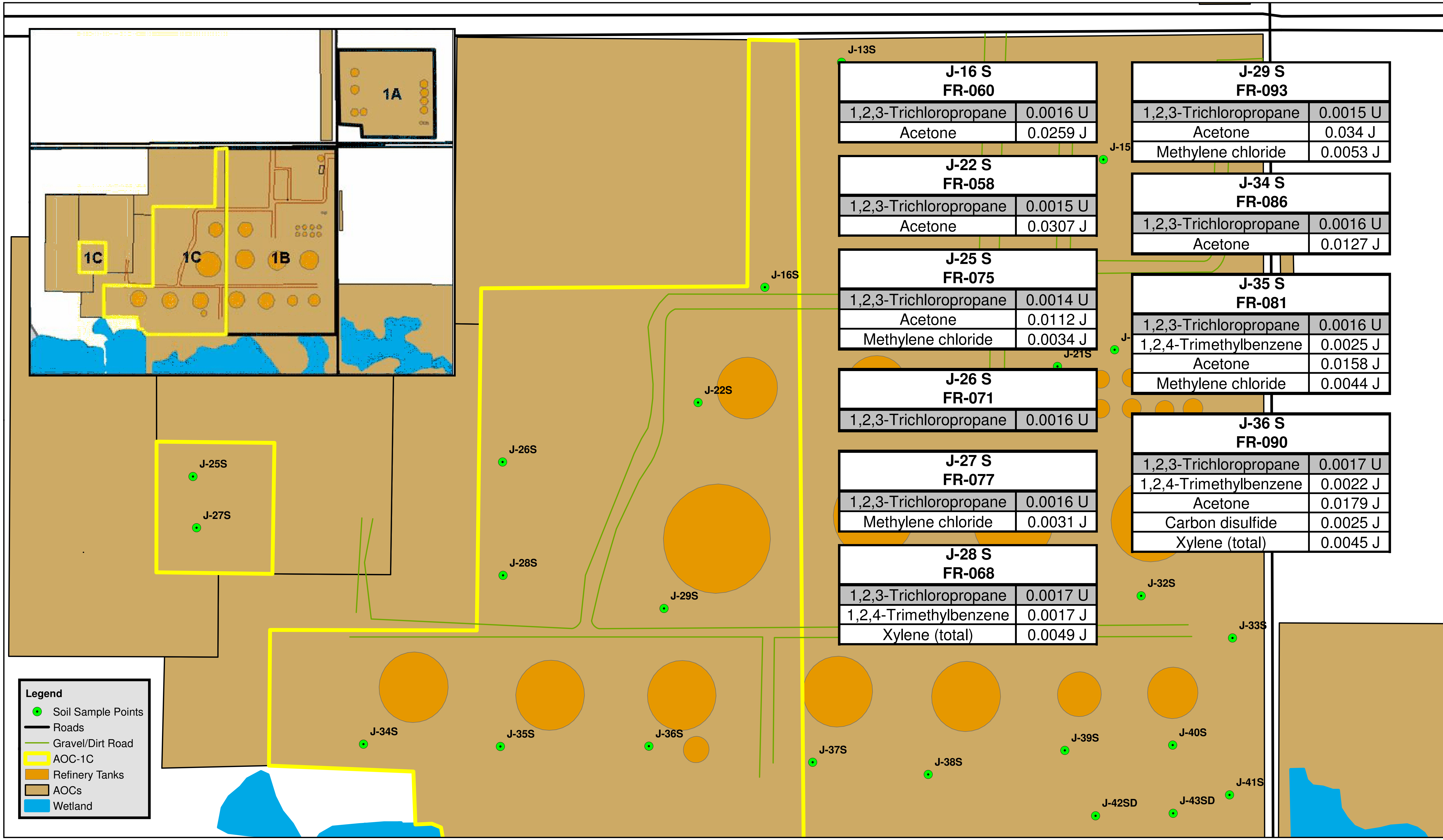
FIGURE
3E



J-16 S FR-060

1,2,3-Trichloropropane	0.0016 U
Acetone	0.0259 J

J-22 S FR-058

1,2,3-Trichloropropane	0.0015 U
Acetone	0.0307 J

J-25 S FR-075

1,2,3-Trichloropropane	0.0014 U
Acetone	0.0112 J
Methylene chloride	0.0034 J

J-26 S FR-071

1,2,3-Trichloropropane	0.0016 U

J-27 S FR-077

1,2,3-Trichloropropane	0.0016 U
Methylene chloride	0.0031 J

J-28 S FR-068

1,2,3-Trichloropropane	0.0017 U
1,2,4-Trimethylbenzene	0.0017 J
Xylene (total)	0.0049 J

J-29 S FR-093

1,2,3-Trichloropropane	0.0015 U
Acetone	0.034 J
Methylene chloride	0.0053 J

J-34 S FR-086

1,2,3-Trichloropropane	0.0016 U
Acetone	0.0127 J

J-35 S FR-081

1,2,3-Trichloropropane	0.0016 U
1,2,4-Trimethylbenzene	0.0025 J
Acetone	0.0158 J
Methylene chloride	0.0044 J

J-36 S FR-090

1,2,3-Trichloropropane	0.0017 U
1,2,4-Trimethylbenzene	0.0022 J
Acetone	0.0179 J
Carbon disulfide	0.0025 J
Xylene (total)	0.0045 J

Notes:

1. Results are posted in mg/kg
2. Qualifiers:
   - U = Undetected at the sample detection limit (SDL)
   - J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

SDL Exceeds TCEQ Screening Level

N

0 100 200

Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1C
Human Health
VOC Subsurface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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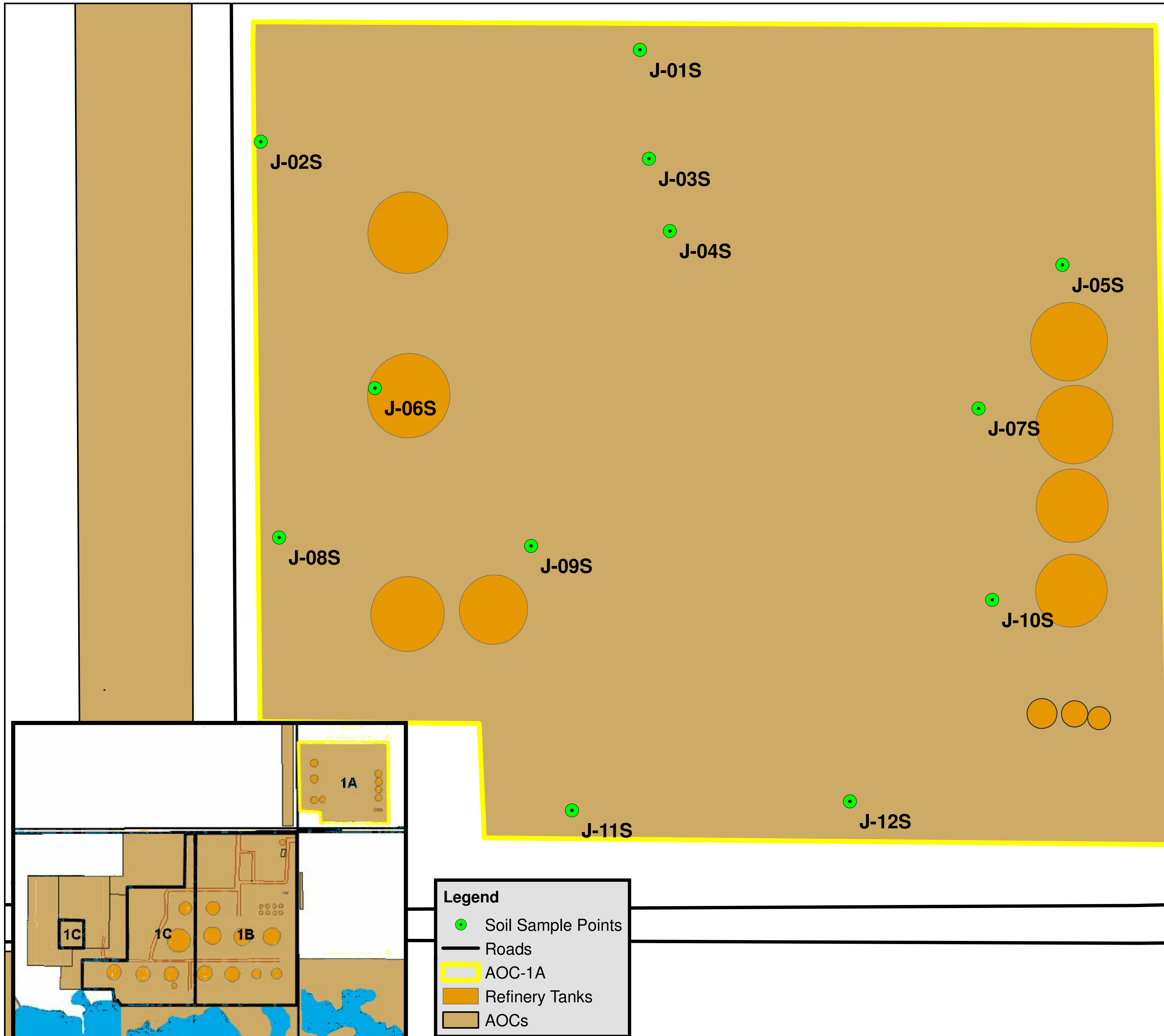
FIGURE
3F



J-01S FR-014	
7,12-Dimethylbenz(a)anthracene	0.22 U
Benzo(a)pyrene	0.074 U
Dibenzo(a,h)anthracene	0.079 U
N-Nitroso-di-n-propylamine	0.092 U
Quinoline	0.22 U

J-02S FR-017	
7,12-Dimethylbenz(a)anthracene	0.19 U
Benzo(a)pyrene	0.061 U
Dibenzo(a,h)anthracene	0.066 U
N-Nitroso-di-n-propylamine	0.076 U
Quinoline	0.19 U

J-03S FR-011	
7,12-Dimethylbenz(a)anthracene	0.22 U
Benzo(a)pyrene	0.072 U
Dibenzo(a,h)anthracene	0.077 U
N-Nitroso-di-n-propylamine	0.089 U
Quinoline	0.22 U

J-04 S FR-008	
4-Bromophenyl phenyl ether	0.34 U
4-Chlorophenyl phenyl ether	0.27 U
7,12-Dimethylbenz(a)anthracene	0.88 U
Benzenethiol	0.88 U
Benzo(a)anthracene	0.33 U
Benzo(a)pyrene	0.29 U
Benzo(b)fluoranthene	0.37 U
Dibenzo(a,h)anthracene	0.31 U
Indeno(1,2,3-cd)pyrene	0.34 U
N-Nitroso-di-n-propylamine	0.35 U
Pyrene	0.683 J
Quinoline	0.88 U

J-05 S FR-034	
1-Methylnaphthalene	0.0835 J
2-Methylnaphthalene	0.0977 J
7,12-Dimethylbenz(a)anthracene	0.20 U
Benzo(a)pyrene	0.066 U
Dibenzo(a,h)anthracene	0.070 U
Naphthalene	0.41
N-Nitroso-di-n-propylamine	0.081 U
Quinoline	0.20 U

J-06S FR-021	
7,12-Dimethylbenz(a)anthracene	0.19 U
Benzo(a)pyrene	0.061 U
Dibenzo(a,h)anthracene	0.066 U
N-Nitroso-di-n-propylamine	0.076 U
Quinoline	0.19 U

J-07S FR-031	
7,12-Dimethylbenz(a)anthracene	0.19 U
Benzo(a)pyrene	0.062 U
Dibenzo(a,h)anthracene	0.066 U
N-Nitroso-di-n-propylamine	0.076 U
Quinoline	0.19 U

J-08S FR-023	
7,12-Dimethylbenz(a)anthracene	0.19 U
Benzo(a)pyrene	0.062 U
Dibenzo(a,h)anthracene	0.066 U
N-Nitroso-di-n-propylamine	0.076 U
Quinoline	0.19 U

J-09S FR-026	
7,12-Dimethylbenz(a)anthracene	0.19 U
Benzo(a)pyrene	0.063 U
Dibenzo(a,h)anthracene	0.067 U
N-Nitroso-di-n-propylamine	0.077 U
Quinoline	0.19 U

J-10 S FR-028	
1-Methylnaphthalene	0.447
2-Methylnaphthalene	0.708
7,12-Dimethylbenz(a)anthracene	0.20 U
Benzo(a)pyrene	0.064 U
Dibenzo(a,h)anthracene	0.068 U
Naphthalene	0.177 J
N-Nitroso-di-n-propylamine	0.079 U
Phenanthrene	0.734
Quinoline	0.20 U

J-11S FR-002	
7,12-Dimethylbenz(a)anthracene	0.22 U
Benzo(a)pyrene	0.072 U
Dibenzo(a,h)anthracene	0.077 U
N-Nitroso-di-n-propylamine	0.089 U
Quinoline	0.22 U

J-12 S FR-005	
1-Methylnaphthalene	0.046 J
7,12-Dimethylbenz(a)anthracene	0.19 U
Benzo(a)pyrene	0.063 U
Dibenzo(a,h)anthracene	0.068 U
N-Nitroso-di-n-propylamine	0.078 U
Quinoline	0.19 U

Notes:

1. Results are posted in mg/kg
2. Qualifiers:
   - U = Undetected at the sample detection limit (SDL)
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SDL Exceeds EPA Screening Level (pink)

SDL Exceeds TCEQ Screening Level (gray)

0 50 100
Feet

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1A
Human Health
SVOC Subsurface Soil Distribution Map

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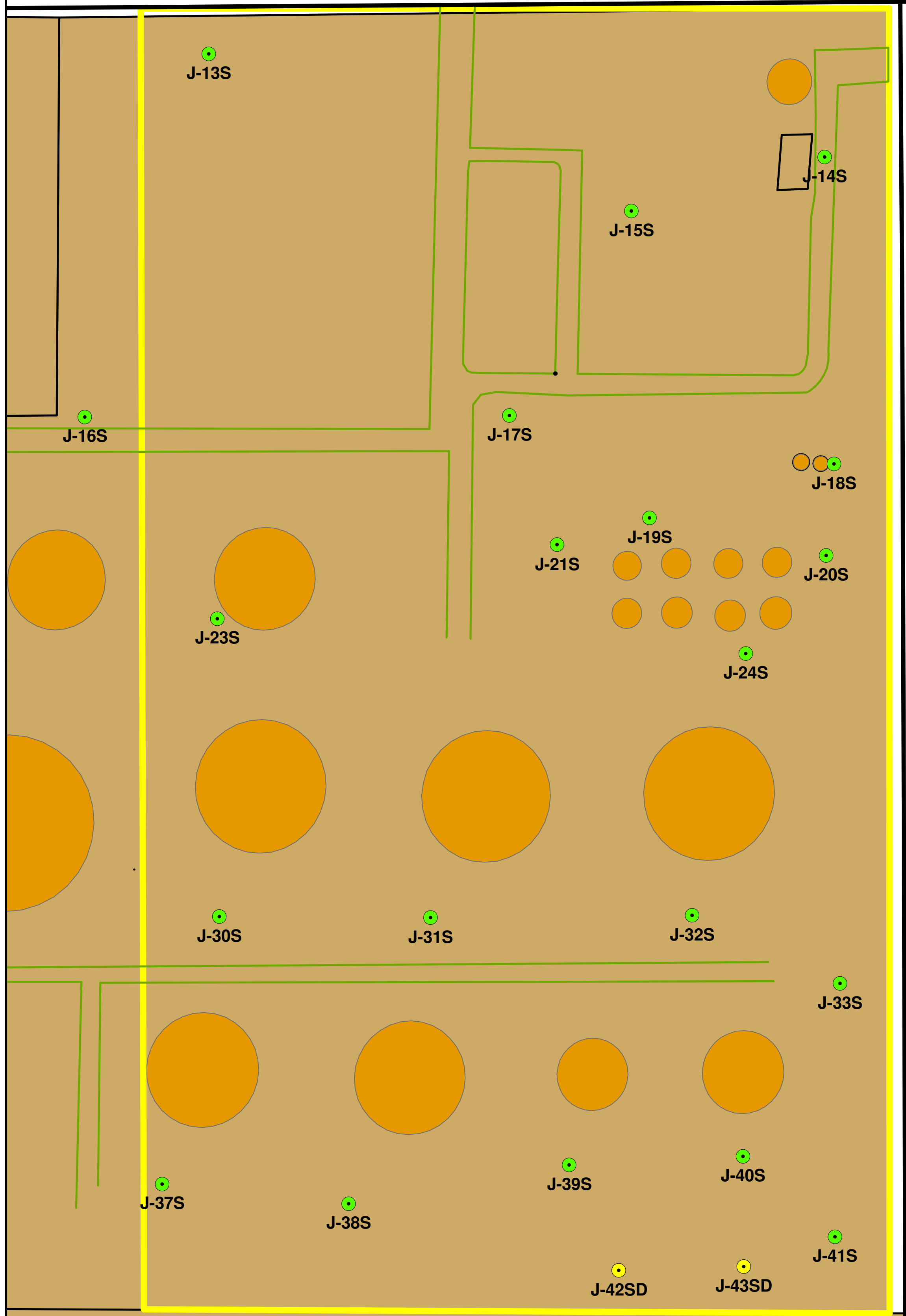
FIGURE
3G



J-13S FR-065	
7,12-Dimethylbenz(a)anthracene	0.21 U
Benzo(a)pyrene	0.067 U
Dibenzo(a,h)anthracene	0.072 U
N-Nitroso-di-n-propylamine	0.083 U
Quinoline	0.21 U

J-14S FR-062	
7,12-Dimethylbenz(a)anthracene	0.21 U
Benzo(a)pyrene	0.067 U
Dibenzo(a,h)anthracene	0.072 U
N-Nitroso-di-n-propylamine	0.083 U
Quinoline	0.21 U

J-15S FR-036	
7,12-Dimethylbenz(a)anthracene	0.19 U
Benzo(a)pyrene	0.061 U
Dibenzo(a,h)anthracene	0.066 U
N-Nitroso-di-n-propylamine	0.076 U
Quinoline	0.19 U

J-17S FR-051	
7,12-Dimethylbenz(a)anthracene	0.21 U
Benzo(a)pyrene	0.069 U
Dibenzo(a,h)anthracene	0.074 U
N-Nitroso-di-n-propylamine	0.085 U

J-18S FR-051	
7,12-Dimethylbenz(a)anthracene	0.20 U
Benzo(a)pyrene	0.065 U
Dibenzo(a,h)anthracene	0.069 U
N-Nitroso-di-n-propylamine	0.080 U
Quinoline	0.20 U

J-19 S FR-041	
1-Methylnaphthalene	0.0507 J
7,12-Dimethylbenz(a)anthracene	0.21 U
Benzo(a)pyrene	0.067 U
Dibenzo(a,h)anthracene	0.072 U
Fluoranthene	0.114 J
Naphthalene	0.157 J
N-Nitroso-di-n-propylamine	0.083 U
Quinoline	0.21 U

J-20S FR-045	
4-Bromophenyl phenyl ether	0.85 U
4-Chlorophenyl phenyl ether	0.68 U
7,12-Dimethylbenz(a)anthracene	2.2 U
Benzenethiol	2.2 U
Benzo(a)anthracene	0.83 U
Benzo(a)pyrene	0.73 U
Benzo(b)fluoranthene	0.94 U
bis(2-Chloroethyl)ether	0.48 U
Dibenzo(a,h)anthracene	0.77 U
Hexachlorobenzene	0.73 U
Indeno(1,2,3-cd)pyrene	0.86 U
N-Nitroso-di-n-propylamine	0.89 U
Quinoline	2.2 U

J-21S FR-038	
7,12-Dimethylbenz(a)anthracene	0.20 U
Benzo(a)pyrene	0.064 U
Dibenzo(a,h)anthracene	0.068 U
N-Nitroso-di-n-propylamine	0.079 U
Quinoline	0.20 U

J-23 S FR-055	
7,12-Dimethylbenz(a)anthracene	0.19 U
Acenaphthene	0.147 J
Anthracene	0.0735 J
Benzo(a)pyrene	0.062 U
Carbazole	0.129 J
Chrysene	0.0901 J
Dibenzo(a,h)anthracene	0.067 U
Dibenzofuran	0.0902 J
Fluorene	0.0964 J
N-Nitroso-di-n-propylamine	0.077 U
Phenanthrene	0.15 J
Quinoline	0.19 U

J-24S FR-043	
7,12-Dimethylbenz(a)anthracene	0.20 U
Benzo(a)pyrene	0.064 U
Dibenzo(a,h)anthracene	0.068 U
N-Nitroso-di-n-propylamine	0.079 U
Quinoline	0.20 U

J-30S FR-095	
7,12-Dimethylbenz(a)anthracene	0.20 U
Benzo(a)pyrene	0.065 U
Dibenzo(a,h)anthracene	0.069 U
N-Nitroso-di-n-propylamine	0.080 U
Quinoline	0.20 U

J-31S FR-101	
7,12-Dimethylbenz(a)anthracene	0.21 U
Benzo(a)pyrene	0.069 U
Dibenzo(a,h)anthracene	0.074 U
N-Nitroso-di-n-propylamine	0.085 U
Quinoline	0.21 U

J-32S FR-097	
7,12-Dimethylbenz(a)anthracene	0.20 U
Benzo(a)pyrene	0.067 U
Dibenzo(a,h)anthracene	0.071 U
N-Nitroso-di-n-propylamine	0.082 U
Quinoline	0.20 U

J-33 S FR-106	
7,12-Dimethylbenz(a)anthracene	0.19 U
Benzo(a)pyrene	0.064 U
Dibenzo(a,h)anthracene	0.068 U
Diethyl phthalate	0.0763 J
N-Nitroso-di-n-propylamine	0.078 U
Quinoline	0.19 U

J-37S FR-120	
7,12-Dimethylbenz(a)anthracene	0.19 U
Benzo(a)pyrene	0.062 U
Dibenzo(a,h)anthracene	0.066 U
N-Nitroso-di-n-propylamine	0.076 U
Quinoline	0.19 U

J-38S FR-117	
7,12-Dimethylbenz(a)anthracene	0.21 U
Benzo(a)pyrene	0.068 U
Dibenzo(a,h)anthracene	0.073 U
N-Nitroso-di-n-propylamine	0.084 U
Quinoline	0.21 U

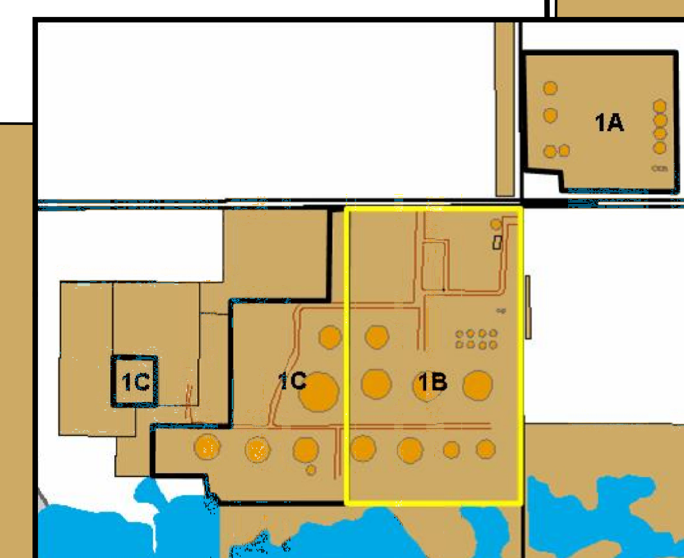
J-39S FR-114	
7,12-Dimethylbenz(a)anthracene	0.20 U
Benzo(a)pyrene	0.065 U
Dibenzo(a,h)anthracene	0.069 U
N-Nitroso-di-n-propylamine	0.080 U
Quinoline	0.20 U

J-40S FR-110A	
7,12-Dimethylbenz(a)anthracene	0.20 U
Benzo(a)pyrene	0.065 U
Dibenzo(a,h)anthracene	0.069 U
N-Nitroso-di-n-propylamine	0.080 U
Quinoline	0.20 U

J-41S FR-103	
7,12-Dimethylbenz(a)anthracene	0.19 U
Benzo(a)pyrene	0.063 U
Dibenzo(a,h)anthracene	0.067 U
Diethyl phthalate	0.0952 J
N-Nitroso-di-n-propylamine	0.078 U
Quinoline	0.19 U

Legend

- Soil Sample Points
- Sediment Sample Points
- Roads
- Gravel/Dirt Road
- AOC-1B
- Refinery Tanks
- AOCs
- Wetland



Notes:

1. Results are posted in mg/kg
2. Qualifiers:
   U = Undetected at the sample detection limit (SDL)
   J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

- SDL Exceeds EPA Screening Level
- SDL Exceeds TCEQ Screening Level
- SDL Exceeds Both EPA and TCEQ Screening Level

N

0 90 180

Feet

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09		
DRAFTED BY:	C. SEATON		
CHECKED BY:	S. HALASZ		
APPROVED BY:			

AOC-1B
Human Health
SVOC Subsurface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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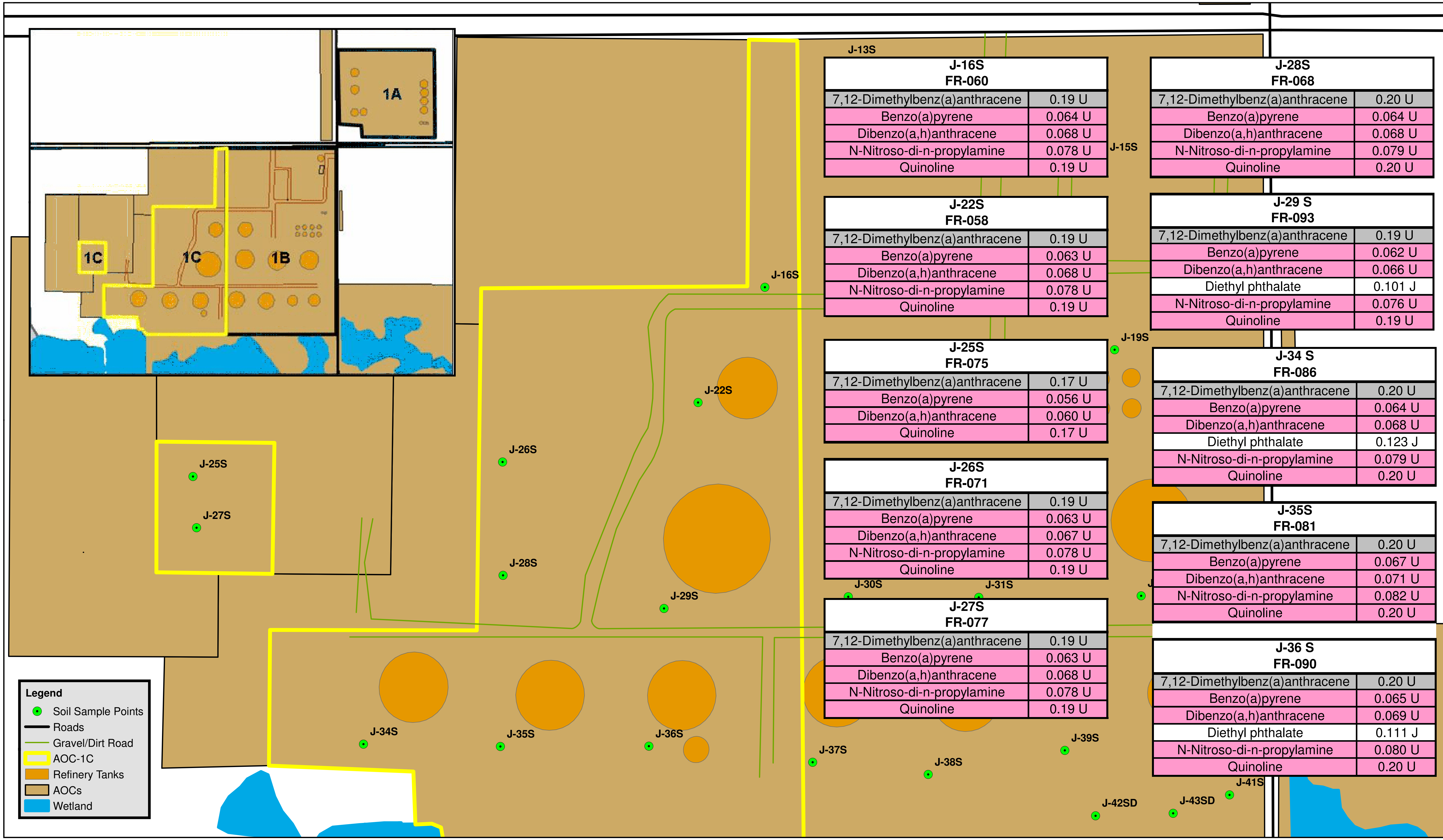
FIGURE
3H



J-16S FR-060	
7,12-Dimethylbenz(a)anthracene	0.19 U
Benzo(a)pyrene	0.064 U
Dibenzo(a,h)anthracene	0.068 U
N-Nitroso-di-n-propylamine	0.078 U
Quinoline	0.19 U

J-22S FR-058	
7,12-Dimethylbenz(a)anthracene	0.19 U
Benzo(a)pyrene	0.063 U
Dibenzo(a,h)anthracene	0.068 U
N-Nitroso-di-n-propylamine	0.078 U
Quinoline	0.19 U

J-25S FR-075	
7,12-Dimethylbenz(a)anthracene	0.17 U
Benzo(a)pyrene	0.056 U
Dibenzo(a,h)anthracene	0.060 U
Quinoline	0.17 U

J-26S FR-071	
7,12-Dimethylbenz(a)anthracene	0.19 U
Benzo(a)pyrene	0.063 U
Dibenzo(a,h)anthracene	0.067 U
N-Nitroso-di-n-propylamine	0.078 U
Quinoline	0.19 U

J-27S FR-077	
7,12-Dimethylbenz(a)anthracene	0.19 U
Benzo(a)pyrene	0.063 U
Dibenzo(a,h)anthracene	0.068 U
N-Nitroso-di-n-propylamine	0.078 U
Quinoline	0.19 U

J-28S FR-068	
7,12-Dimethylbenz(a)anthracene	0.20 U
Benzo(a)pyrene	0.064 U
Dibenzo(a,h)anthracene	0.068 U
N-Nitroso-di-n-propylamine	0.079 U
Quinoline	0.20 U

J-29 S FR-093	
7,12-Dimethylbenz(a)anthracene	0.19 U
Benzo(a)pyrene	0.062 U
Dibenzo(a,h)anthracene	0.066 U
Diethyl phthalate	0.101 J
N-Nitroso-di-n-propylamine	0.076 U
Quinoline	0.19 U

J-34 S FR-086	
7,12-Dimethylbenz(a)anthracene	0.20 U
Benzo(a)pyrene	0.064 U
Dibenzo(a,h)anthracene	0.068 U
Diethyl phthalate	0.123 J
N-Nitroso-di-n-propylamine	0.079 U
Quinoline	0.20 U

J-35S FR-081	
7,12-Dimethylbenz(a)anthracene	0.20 U
Benzo(a)pyrene	0.067 U
Dibenzo(a,h)anthracene	0.071 U
N-Nitroso-di-n-propylamine	0.082 U
Quinoline	0.20 U

J-36 S FR-090	
7,12-Dimethylbenz(a)anthracene	0.20 U
Benzo(a)pyrene	0.065 U
Dibenzo(a,h)anthracene	0.069 U
Diethyl phthalate	0.111 J
N-Nitroso-di-n-propylamine	0.080 U
Quinoline	0.20 U

Notes:

1. Results are posted in mg/kg
2. Qualifiers:
   - U = Undetected at the sample detection limit (SDL)
   - J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

SDL Exceeds EPA Screening Level

SDL Exceeds TCEQ Screening Level

N

0 90 180

Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1C
Human Health
SVOC Subsurface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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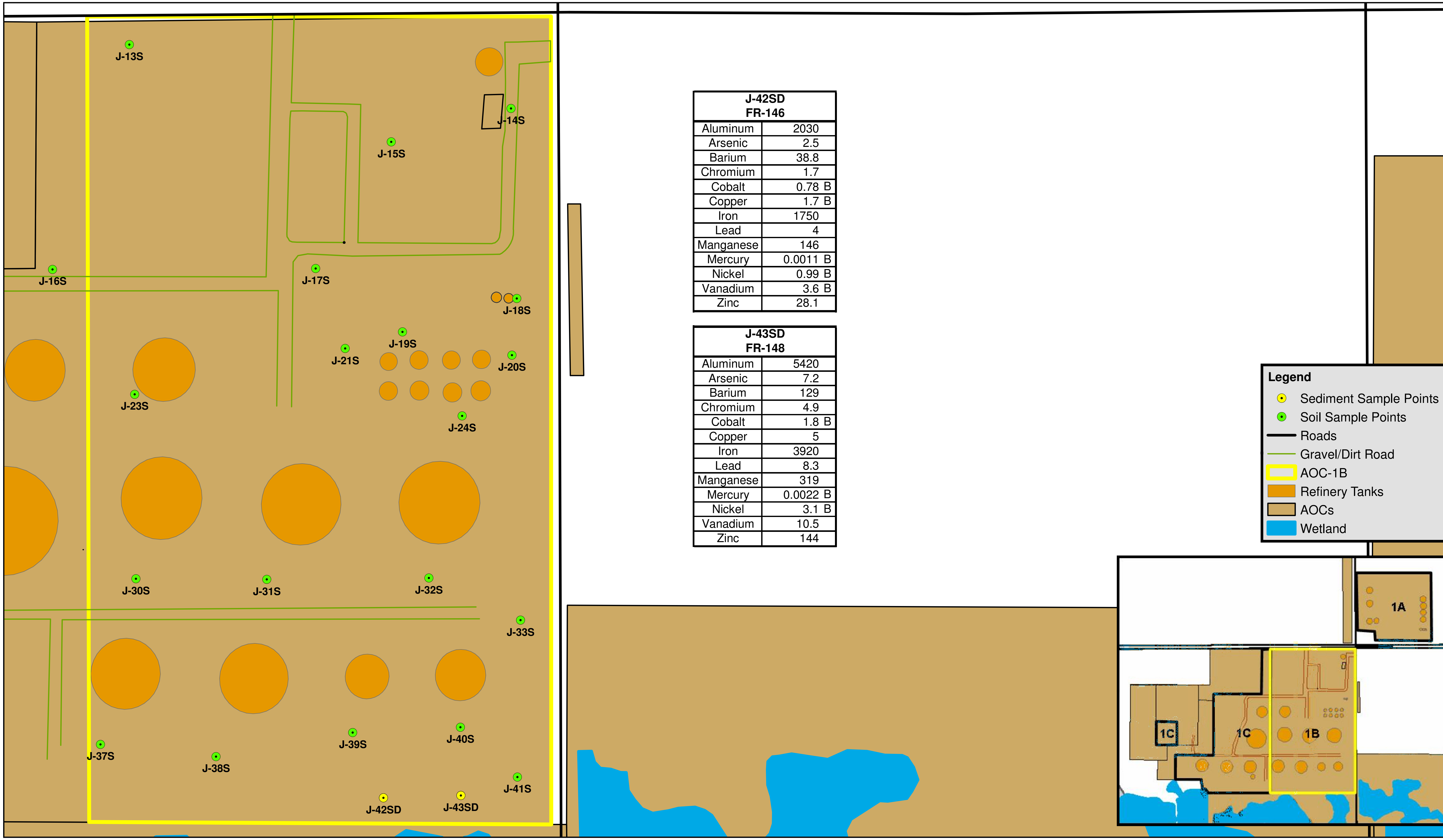
FIGURE
31



J-42SD FR-146	
Aluminum	2030
Arsenic	2.5
Barium	38.8
Chromium	1.7
Cobalt	0.78 B
Copper	1.7 B
Iron	1750
Lead	4
Manganese	146
Mercury	0.0011 B
Nickel	0.99 B
Vanadium	3.6 B
Zinc	28.1

J-43SD FR-148	
Aluminum	5420
Arsenic	7.2
Barium	129
Chromium	4.9
Cobalt	1.8 B
Copper	5
Iron	3920
Lead	8.3
Manganese	319
Mercury	0.0022 B
Nickel	3.1 B
Vanadium	10.5
Zinc	144

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

   B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

N

0 100 200

Feet

DATE DRAWN:	DATE REVISED:
4/30/08	4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1B
Human Health
Metal Sediment Distribution Map

FALCON REFINERY
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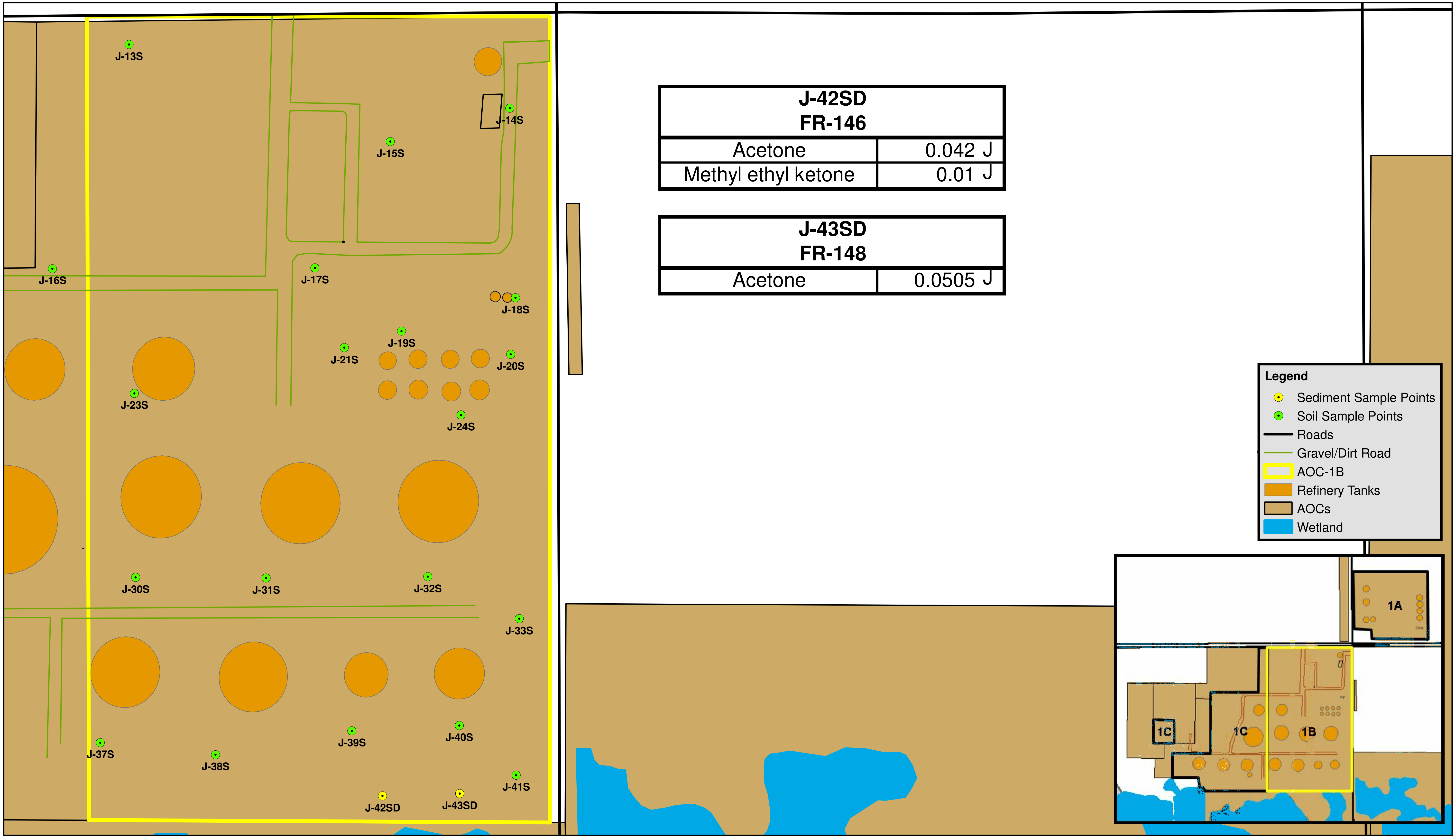
FIGURE
4A



J-42SD FR-146	
Acetone	0.042 J
Methyl ethyl ketone	0.01 J

J-43SD FR-148	
Acetone	0.0505 J

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

0 100 200

Feet

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1B
Human Health
VOC Sediment Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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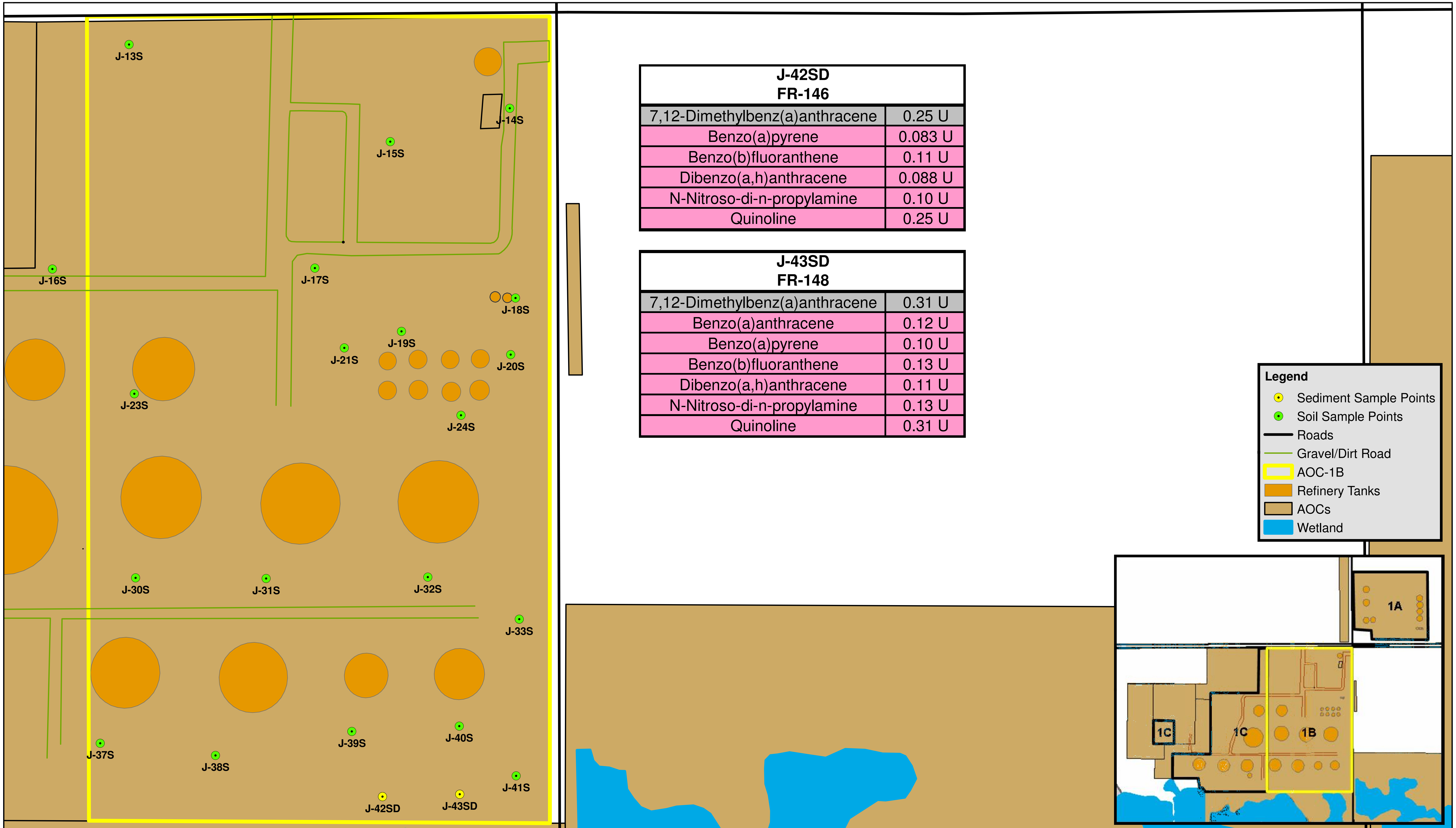
FIGURE

4B



J-42SD FR-146	
7,12-Dimethylbenz(a)anthracene	0.25 U
Benzo(a)pyrene	0.083 U
Benzo(b)fluoranthene	0.11 U
Dibenzo(a,h)anthracene	0.088 U
N-Nitroso-di-n-propylamine	0.10 U
Quinoline	0.25 U

J-43SD FR-148	
7,12-Dimethylbenz(a)anthracene	0.31 U
Benzo(a)anthracene	0.12 U
Benzo(a)pyrene	0.10 U
Benzo(b)fluoranthene	0.13 U
Dibenzo(a,h)anthracene	0.11 U
N-Nitroso-di-n-propylamine	0.13 U
Quinoline	0.31 U

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

SDL Exceeds EPA Screening Level

SDL Exceeds TCEQ Screening Level

N

0 90 180

Feet

DATE DRAWN: 4/30/08 | DATE REVISED: 4/1/09

DRAFTED BY: C. SEATON

CHECKED BY: S. HALASZ

APPROVED BY:

AOC-1B
Human Health
SVOC Sediment Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 | FILE NAME: Falcon Refinery Base Map

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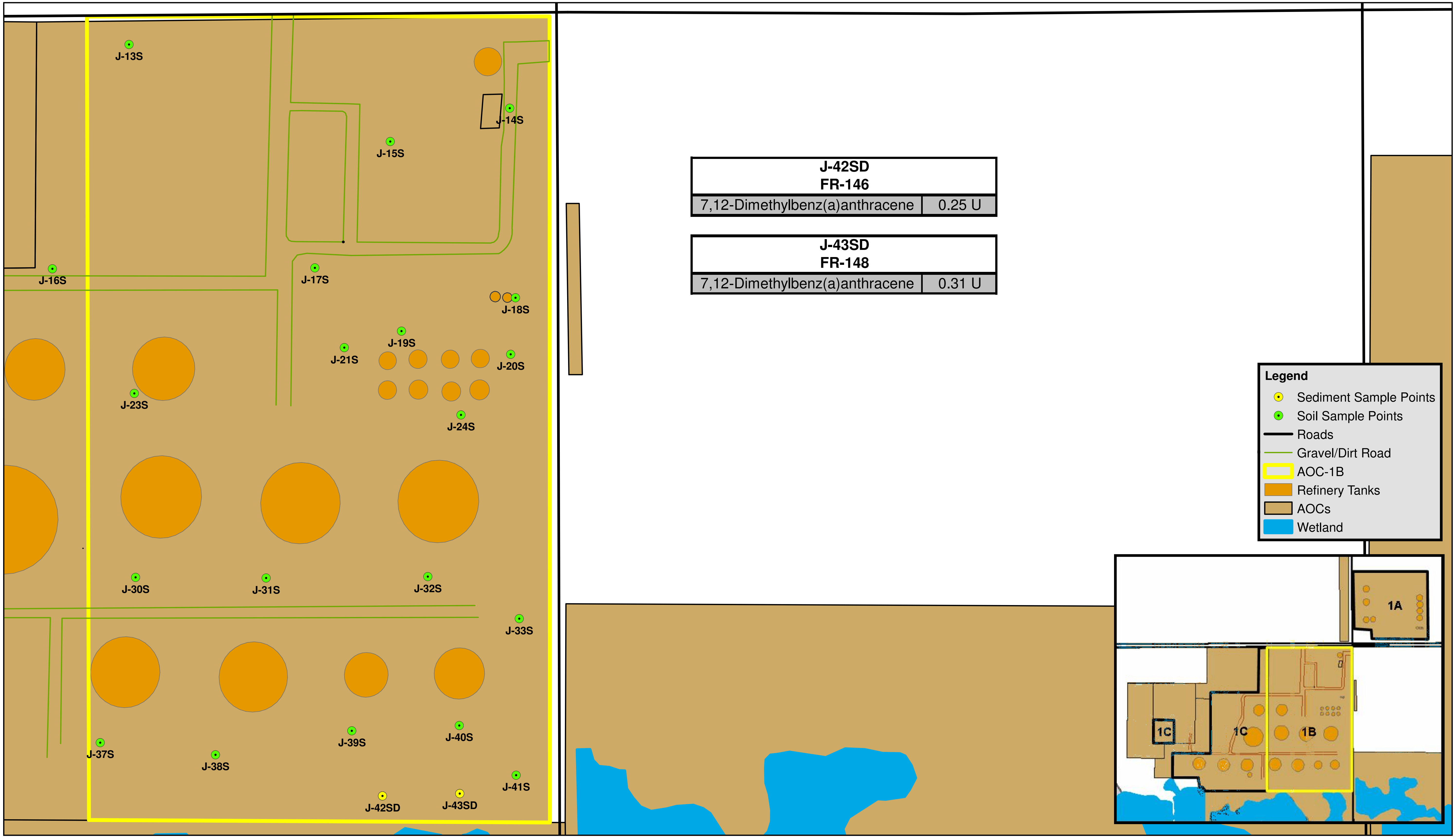
FIGURE

4C



J-42SD FR-146	
7,12-Dimethylbenz(a)anthracene	0.25 U

J-43SD FR-148	
7,12-Dimethylbenz(a)anthracene	0.31 U

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

SDL Exceeds TCEQ Screening Level

N

0 90 180

Feet

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-1B
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SVOC Sediment Distribution Map

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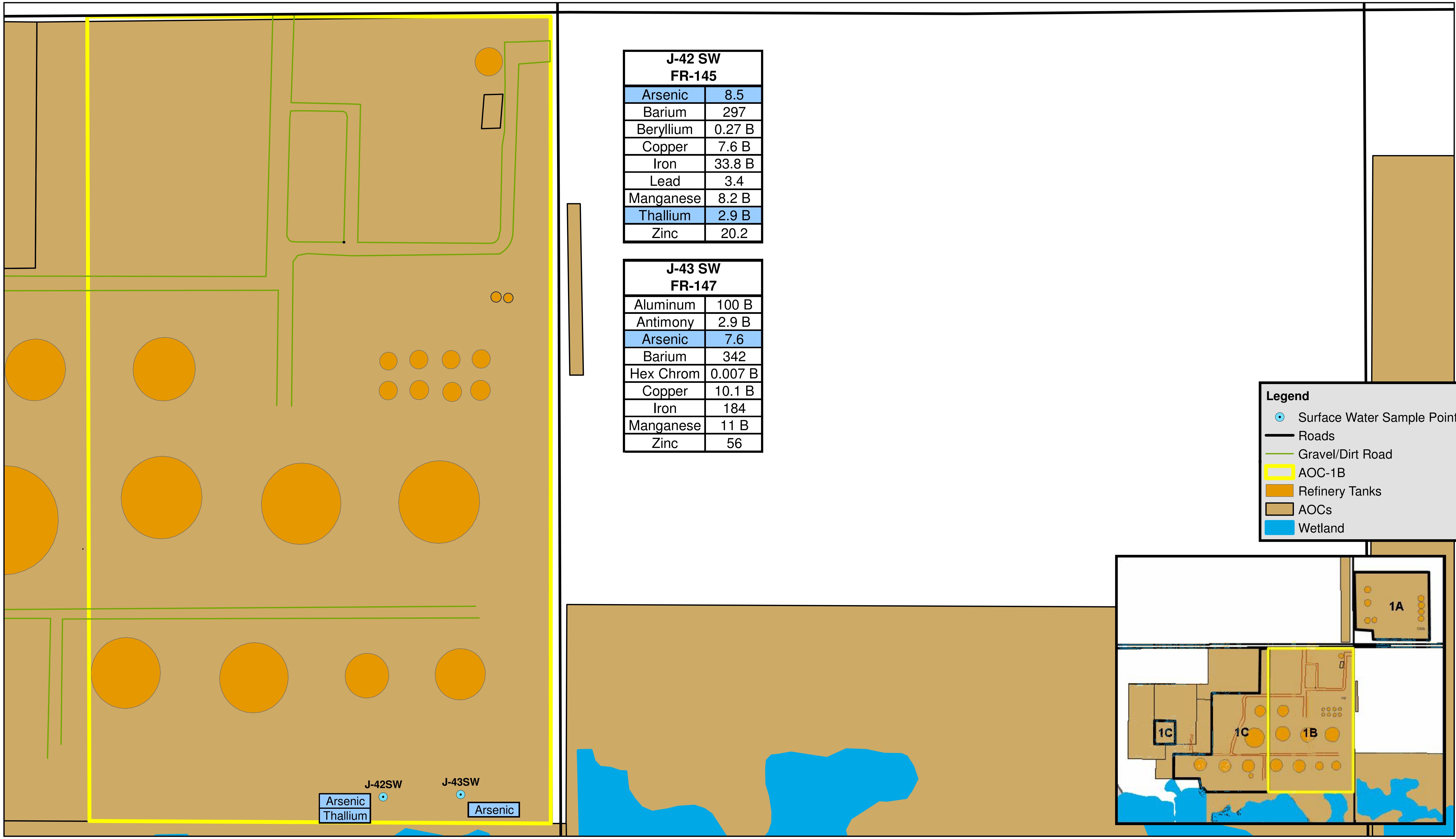
FIGURE
4C



J-42 SW FR-145	
Arsenic	8.5
Barium	297
Beryllium	0.27 B
Copper	7.6 B
Iron	33.8 B
Lead	3.4
Manganese	8.2 B
Thallium	2.9 B
Zinc	20.2

J-43 SW FR-147	
Aluminum	100 B
Antimony	2.9 B
Arsenic	7.6
Barium	342
Hex Chrom	0.007 B
Copper	10.1 B
Iron	184
Manganese	11 B
Zinc	56

Notes:

1. Results are posted in µg/l
   Hex Chrom posted in mg/l
2. Qualifiers:

   B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds ^{SW}RBELs

N

0 90 180
Feet

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1B
Human Health
Metal Surface Water Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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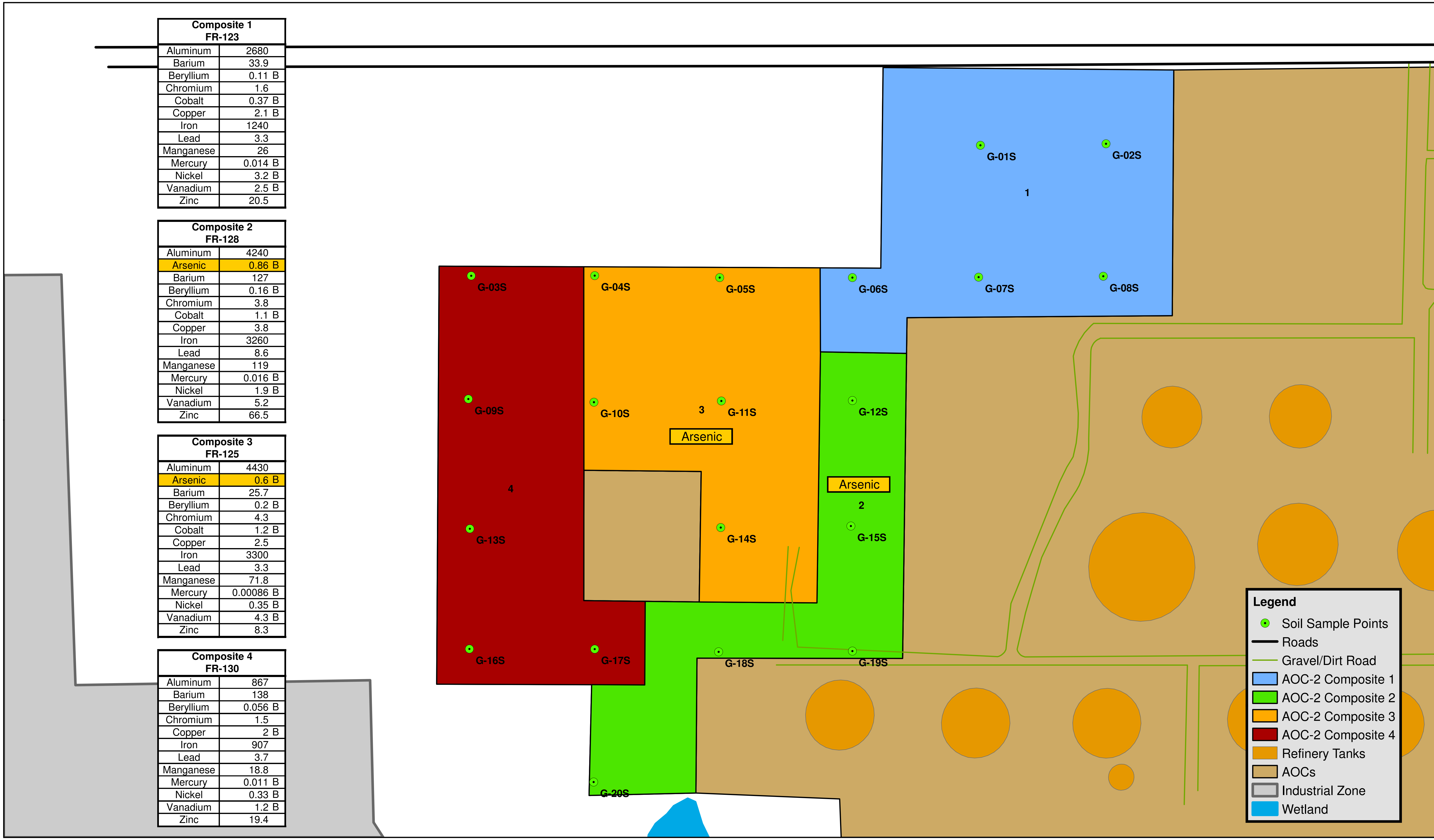
FIGURE
5

Composite 1 FR-123	
Aluminum	2680
Barium	33.9
Beryllium	0.11 B
Chromium	1.6
Cobalt	0.37 B
Copper	2.1 B
Iron	1240
Lead	3.3
Manganese	26
Mercury	0.014 B
Nickel	3.2 B
Vanadium	2.5 B
Zinc	20.5

Composite 2 FR-128	
Aluminum	4240
Arsenic	0.86 B
Barium	127
Beryllium	0.16 B
Chromium	3.8
Cobalt	1.1 B
Copper	3.8
Iron	3260
Lead	8.6
Manganese	119
Mercury	0.016 B
Nickel	1.9 B
Vanadium	5.2
Zinc	66.5

Composite 3 FR-125	
Aluminum	4430
Arsenic	0.6 B
Barium	25.7
Beryllium	0.2 B
Chromium	4.3
Cobalt	1.2 B
Copper	2.5
Iron	3300
Lead	3.3
Manganese	71.8
Mercury	0.00086 B
Nickel	0.35 B
Vanadium	4.3 B
Zinc	8.3

Composite 4 FR-130	
Aluminum	867
Barium	138
Beryllium	0.056 B
Chromium	1.5
Copper	2 B
Iron	907
Lead	3.7
Manganese	18.8
Mercury	0.011 B
Nickel	0.33 B
Vanadium	1.2 B
Zinc	19.4



Notes:

1. Results are posted in mg/kg

Exceeds EPA Region 6 MSSL

2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

N

0 100 200

Feet

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-2
Human Health
Metal Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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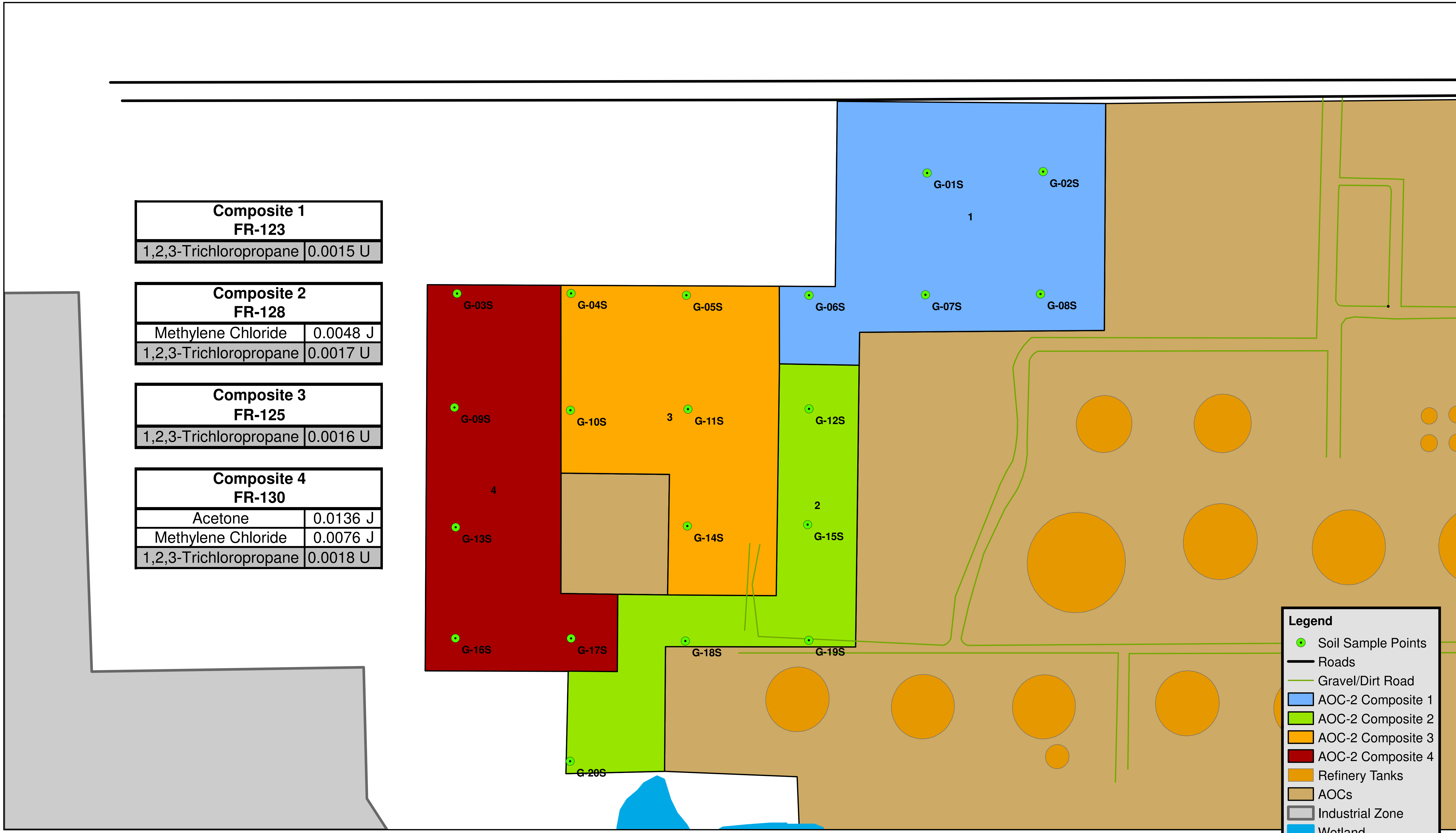
FIGURE
6A



Composite 1 FR-123	
1,2,3-Trichloropropane	0.0015 U

Composite 2 FR-128	
Methylene Chloride	0.0048 J
1,2,3-Trichloropropane	0.0017 U

Composite 3 FR-125	
1,2,3-Trichloropropane	0.0016 U

Composite 4 FR-130	
Acetone	0.0136 J
Methylene Chloride	0.0076 J
1,2,3-Trichloropropane	0.0018 U

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

   U = Undetected at the sample detection limit (SDL)

   J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

SDL Exceeds TCEQ Screening Level

N

0 90 180

Feet

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
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APPROVED BY:	

AOC-2
Human Health
VOC Surface Soil Distribution Map

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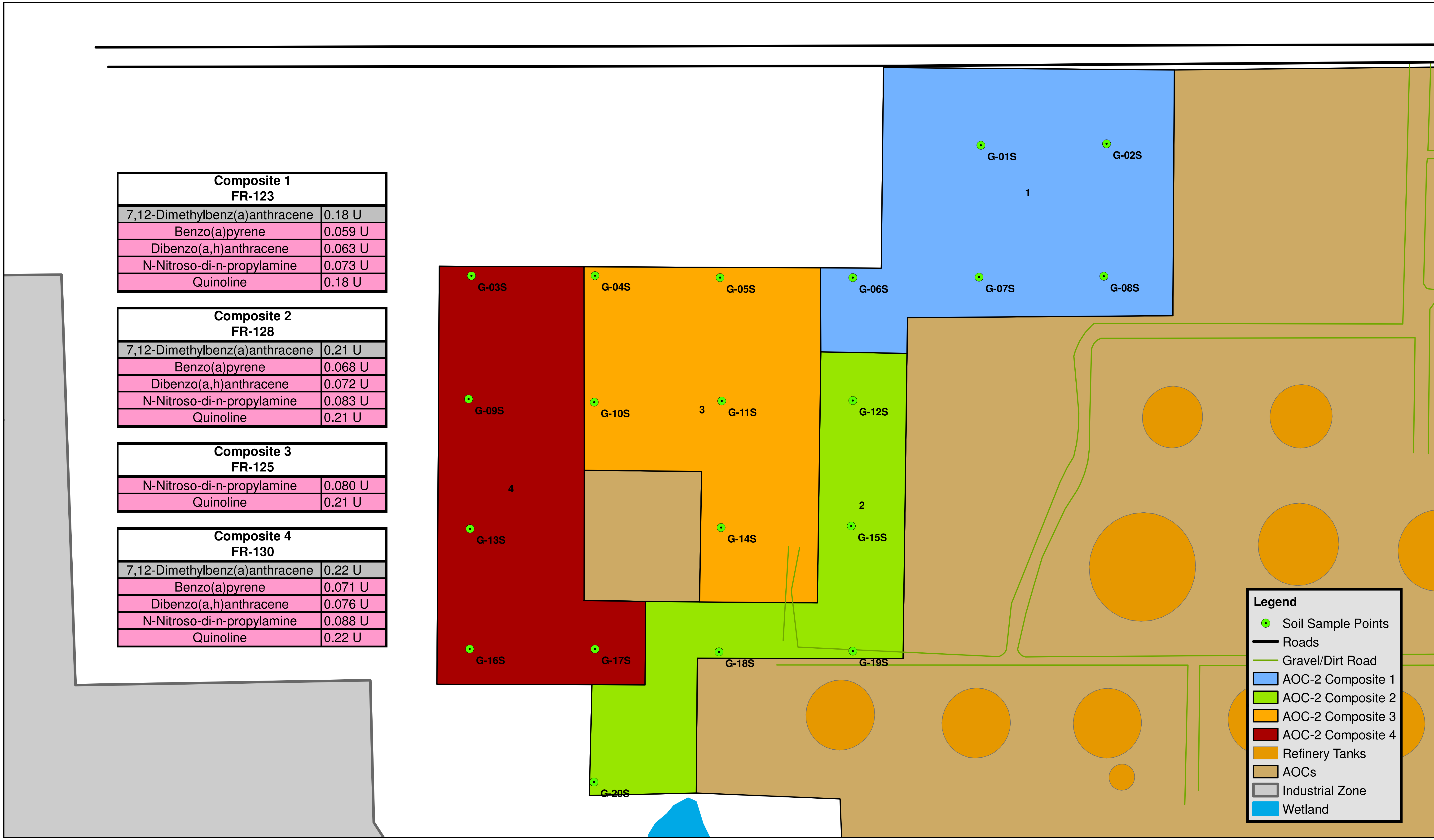
FIGURE

6B



Composite 1 FR-123	
7,12-Dimethylbenz(a)anthracene	0.18 U
Benzo(a)pyrene	0.059 U
Dibenzo(a,h)anthracene	0.063 U
N-Nitroso-di-n-propylamine	0.073 U
Quinoline	0.18 U

Composite 2 FR-128	
7,12-Dimethylbenz(a)anthracene	0.21 U
Benzo(a)pyrene	0.068 U
Dibenzo(a,h)anthracene	0.072 U
N-Nitroso-di-n-propylamine	0.083 U
Quinoline	0.21 U

Composite 3 FR-125	
N-Nitroso-di-n-propylamine	0.080 U
Quinoline	0.21 U

Composite 4 FR-130	
7,12-Dimethylbenz(a)anthracene	0.22 U
Benzo(a)pyrene	0.071 U
Dibenzo(a,h)anthracene	0.076 U
N-Nitroso-di-n-propylamine	0.088 U
Quinoline	0.22 U

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

SDL Exceeds EPA Screening Level

SDL Exceeds TCEQ Screening Level

N

0 100 200

Feet

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-2
Human Health
SVOC Surface Soil Distribution Map

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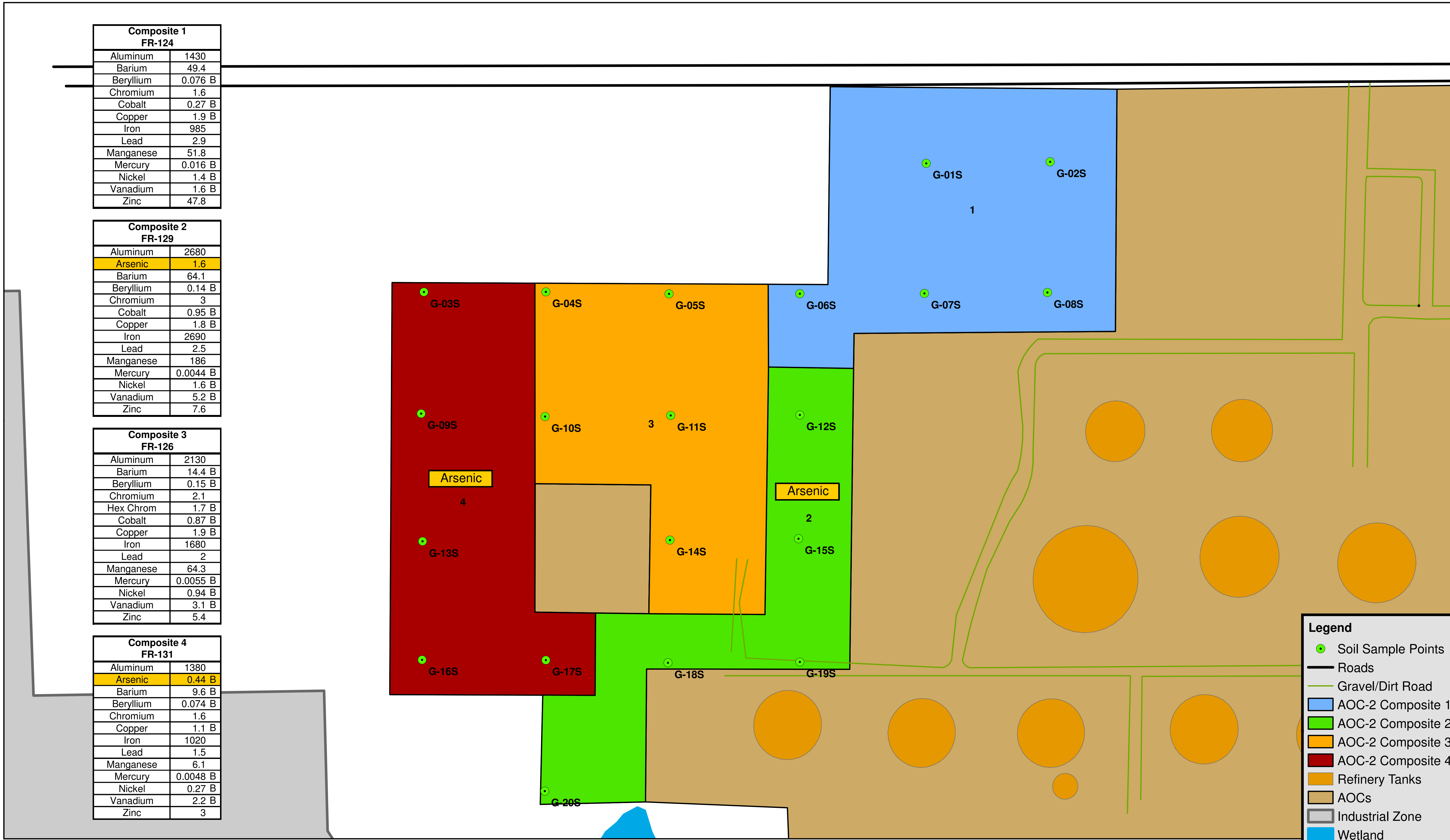
FIGURE
6C

Composite 1 FR-124	
Aluminum	1430
Barium	49.4
Beryllium	0.076 B
Chromium	1.6
Cobalt	0.27 B
Copper	1.9 B
Iron	985
Lead	2.9
Manganese	51.8
Mercury	0.016 B
Nickel	1.4 B
Vanadium	1.6 B
Zinc	47.8

Composite 2 FR-129	
Aluminum	2680
Arsenic	1.6
Barium	64.1
Beryllium	0.14 B
Chromium	3
Cobalt	0.95 B
Copper	1.8 B
Iron	2690
Lead	2.5
Manganese	186
Mercury	0.0044 B
Nickel	1.6 B
Vanadium	5.2 B
Zinc	7.6

Composite 3 FR-126	
Aluminum	2130
Barium	14.4 B
Beryllium	0.15 B
Chromium	2.1
Hex Chrom	1.7 B
Cobalt	0.87 B
Copper	1.9 B
Iron	1680
Lead	2
Manganese	64.3
Mercury	0.0055 B
Nickel	0.94 B
Vanadium	3.1 B
Zinc	5.4

Composite 4 FR-131	
Aluminum	1380
Arsenic	0.44 B
Barium	9.6 B
Beryllium	0.074 B
Chromium	1.6
Copper	1.1 B
Iron	1020
Lead	1.5
Manganese	6.1
Mercury	0.0048 B
Nickel	0.27 B
Vanadium	2.2 B
Zinc	3



Notes:

1. Results are posted in mg/kg
2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds EPA Region 6 MSSL

DATE DRAWN: 07/24/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-2
Human Health
Metal Subsurface Soil Distribution Map

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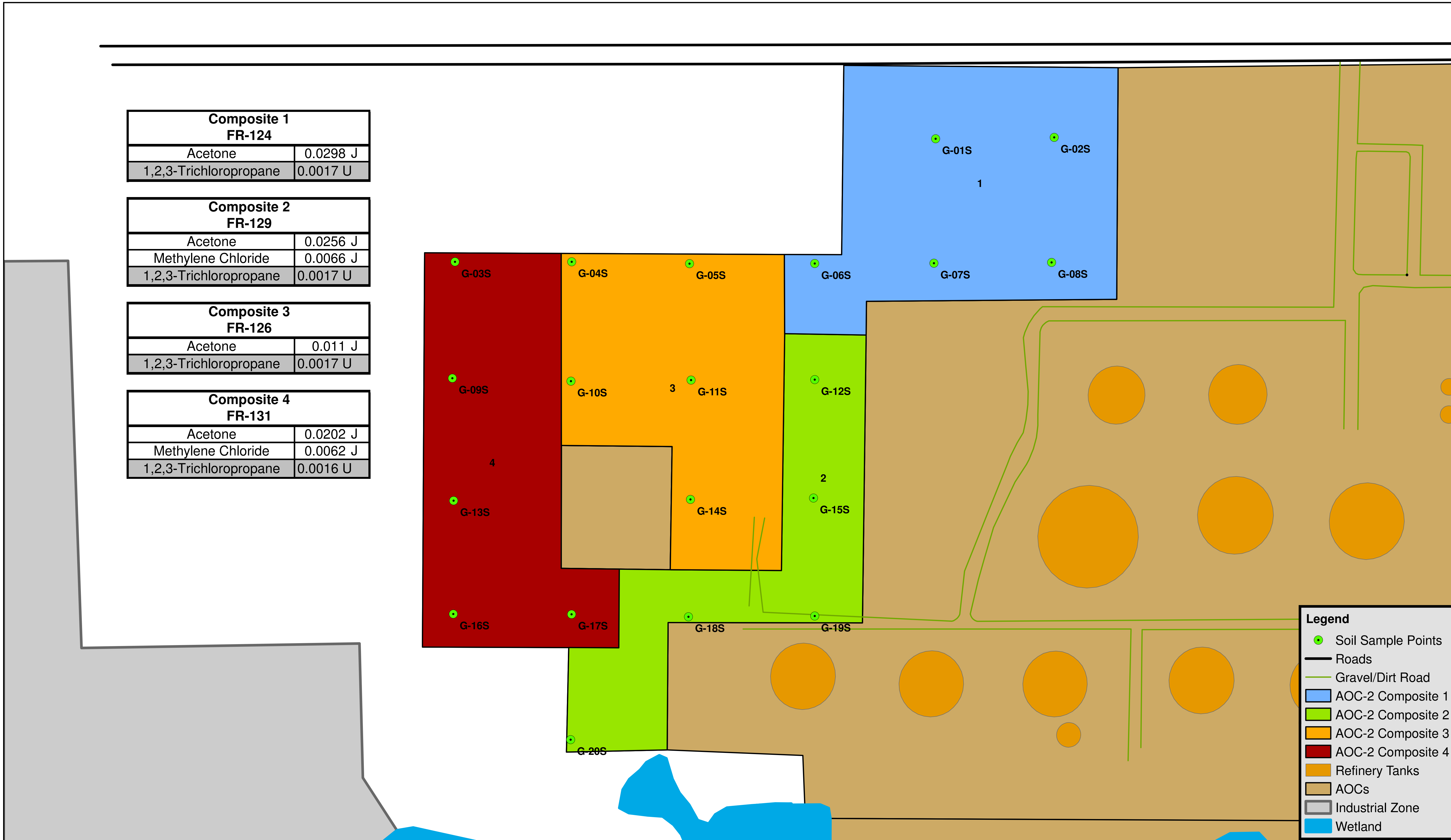
FIGURE
7A



Composite 1 FR-124	
Acetone	0.0298 J
1,2,3-Trichloropropane	0.0017 U

Composite 2 FR-129	
Acetone	0.0256 J
Methylene Chloride	0.0066 J
1,2,3-Trichloropropane	0.0017 U

Composite 3 FR-126	
Acetone	0.011 J
1,2,3-Trichloropropane	0.0017 U

Composite 4 FR-131	
Acetone	0.0202 J
Methylene Chloride	0.0062 J
1,2,3-Trichloropropane	0.0016 U

Notes:

1. Results are posted in mg/kg
2. Qualifiers:
   - U = Undetected at the sample detection limit (SDL)
   - J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

SDL Exceeds TCEQ Screening Level

N

0 100 200

Feet

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09	
DRAFTED BY:	C. SEATON	
CHECKED BY:	S. HALASZ	
APPROVED BY:		

AOC-2
Human Health
VOC Subsurface Soil Distribution Map

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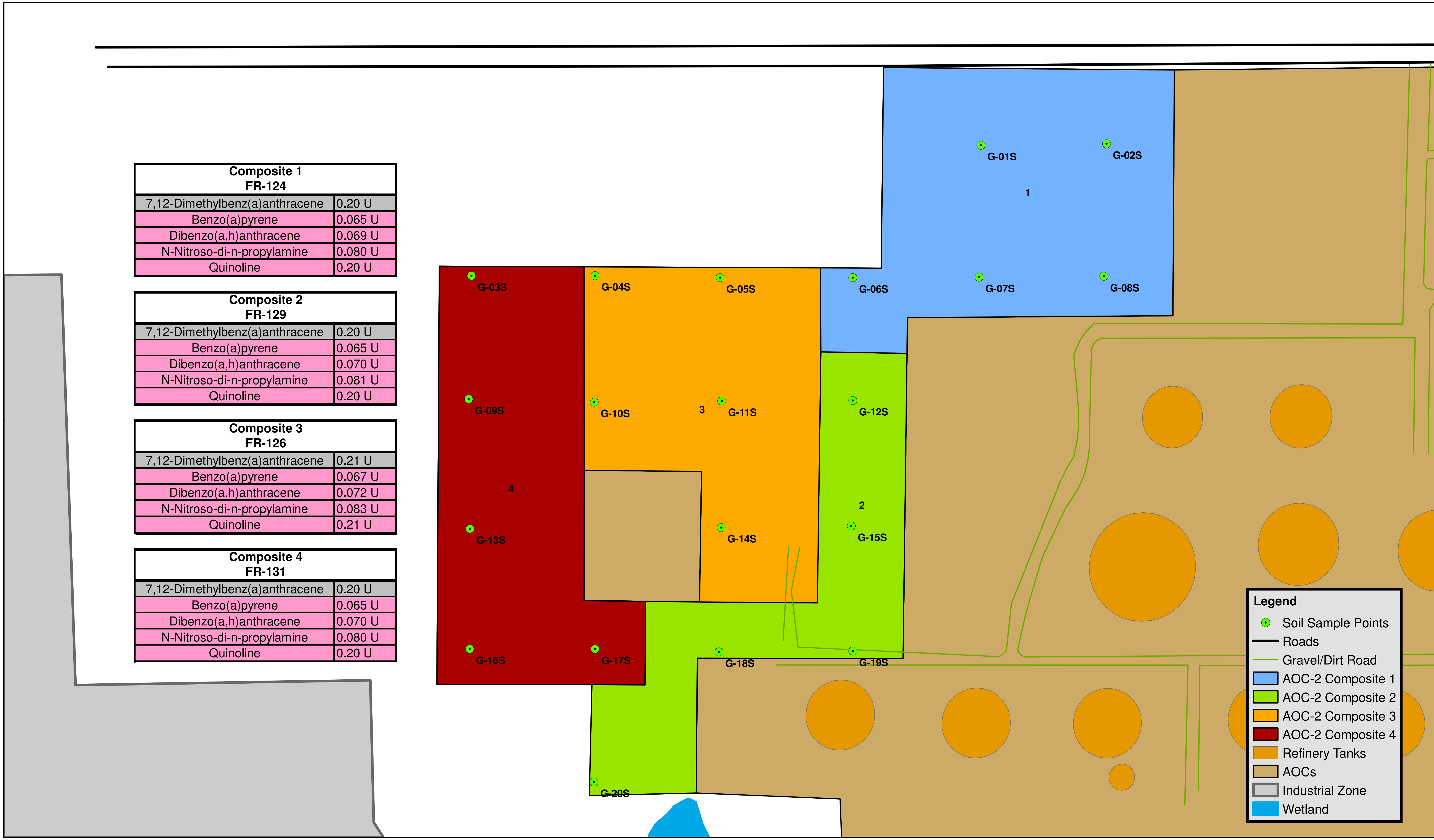
FIGURE
7B



Composite 1 FR-124	
7,12-Dimethylbenz(a)anthracene	0.20 U
Benzo(a)pyrene	0.065 U
Dibenzo(a,h)anthracene	0.069 U
N-Nitroso-di-n-propylamine	0.080 U
Quinoline	0.20 U

Composite 2 FR-129	
7,12-Dimethylbenz(a)anthracene	0.20 U
Benzo(a)pyrene	0.065 U
Dibenzo(a,h)anthracene	0.070 U
N-Nitroso-di-n-propylamine	0.081 U
Quinoline	0.20 U

Composite 3 FR-126	
7,12-Dimethylbenz(a)anthracene	0.21 U
Benzo(a)pyrene	0.067 U
Dibenzo(a,h)anthracene	0.072 U
N-Nitroso-di-n-propylamine	0.083 U
Quinoline	0.21 U

Composite 4 FR-131	
7,12-Dimethylbenz(a)anthracene	0.20 U
Benzo(a)pyrene	0.065 U
Dibenzo(a,h)anthracene	0.070 U
N-Nitroso-di-n-propylamine	0.080 U
Quinoline	0.20 U

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

SDL Exceeds EPA Screening Level

SDL Exceeds TCEQ Screening Level

N

0 100 200

Feet

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-2
Human Health
SVOC Subsurface Soil Distribution Map

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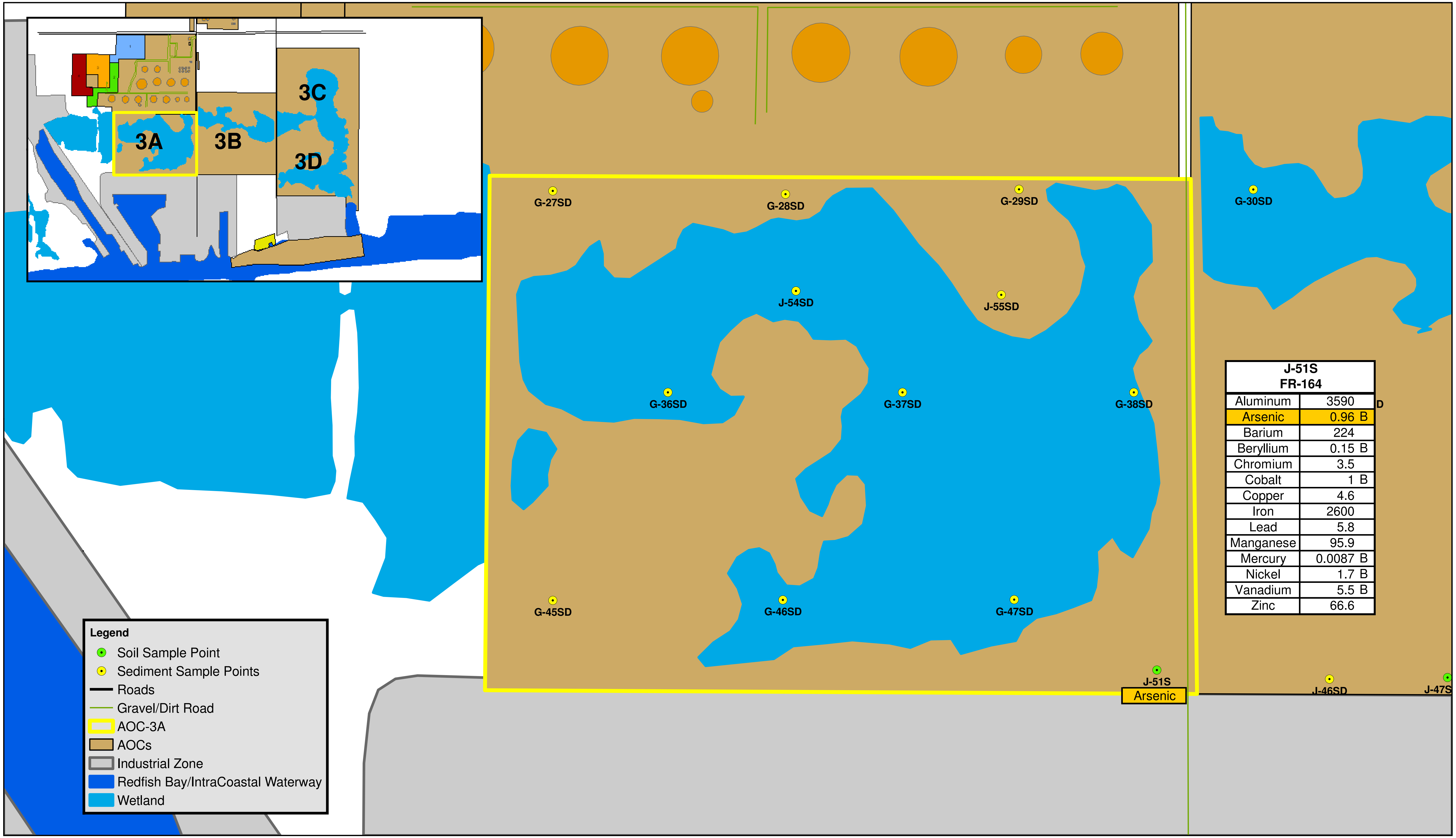
FIGURE
7C



J-51S FR-164	
Aluminum	3590
Arsenic	0.96 B
Barium	224
Beryllium	0.15 B
Chromium	3.5
Cobalt	1 B
Copper	4.6
Iron	2600
Lead	5.8
Manganese	95.9
Mercury	0.0087 B
Nickel	1.7 B
Vanadium	5.5 B
Zinc	66.6

Notes:

1. Results are posted in mg/kg

2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds EPA Region 6 MSSL

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
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APPROVED BY:	

AOC-3A
Human Health
Metal Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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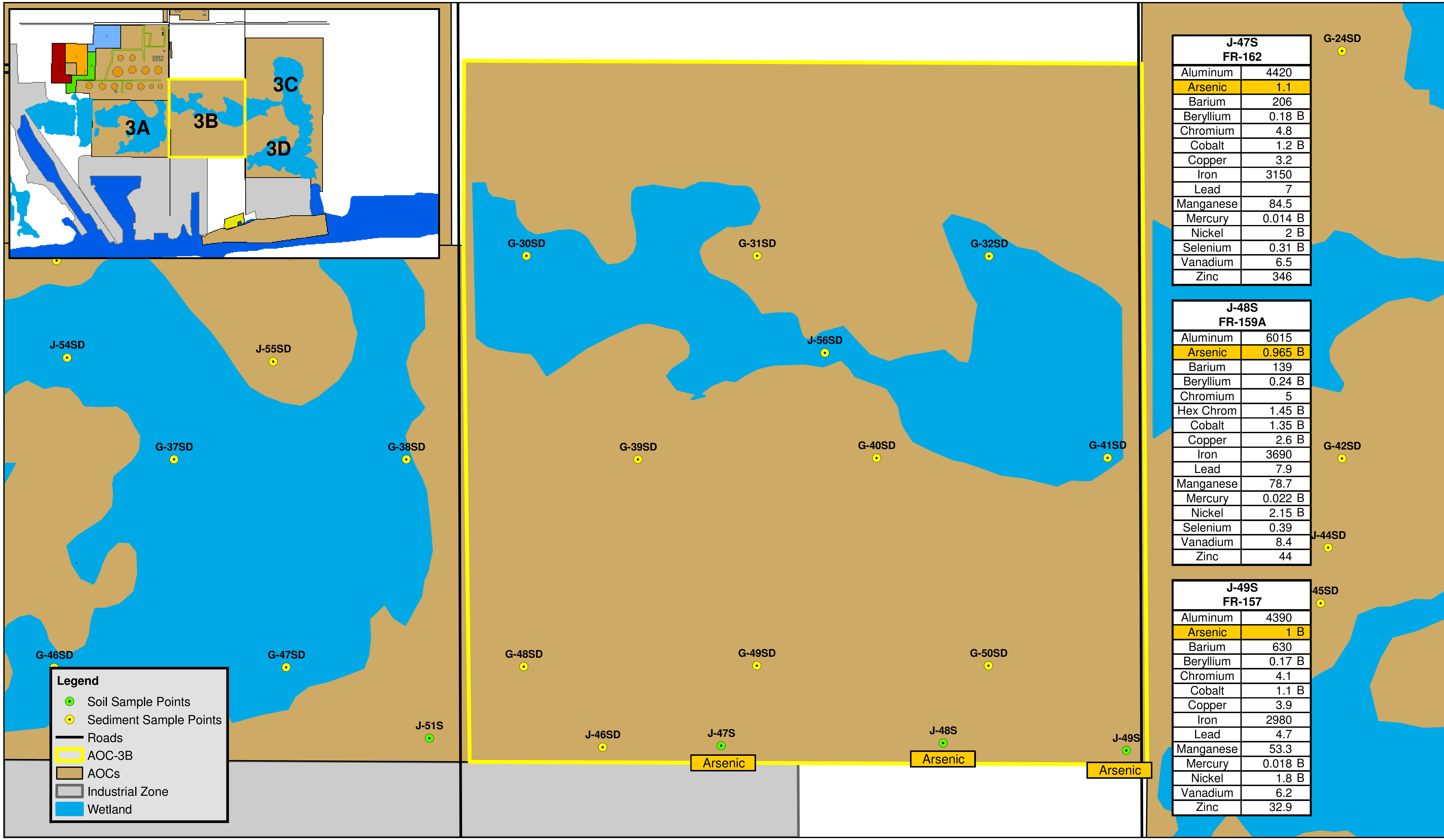
FIGURE
8A



J-47S FR-162	
Aluminum	4420
Arsenic	1.1
Barium	206
Beryllium	0.18 B
Chromium	4.8
Cobalt	1.2 B
Copper	3.2
Iron	3150
Lead	7
Manganese	84.5
Mercury	0.014 B
Nickel	2 B
Selenium	0.31 B
Vanadium	6.5
Zinc	346

J-48S FR-159A	
Aluminum	6015
Arsenic	0.965 B
Barium	139
Beryllium	0.24 B
Chromium	5
Hex Chrom	1.45 B
Cobalt	1.35 B
Copper	2.6 B
Iron	3690
Lead	7.9
Manganese	78.7
Mercury	0.022 B
Nickel	2.15 B
Selenium	0.39
Vanadium	8.4
Zinc	44

J-49S FR-157	
Aluminum	4390
Arsenic	1 B
Barium	630
Beryllium	0.17 B
Chromium	4.1
Cobalt	1.1 B
Copper	3.9
Iron	2980
Lead	4.7
Manganese	53.3
Mercury	0.018 B
Nickel	1.8 B
Vanadium	6.2
Zinc	32.9

Notes:

1. Results are posted in mg/kg
   Hex Chrom posted in mg/l

Exceeds EPA Region 6 MSSL

2. Qualifiers:

   B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-3B
Human Health
Metal Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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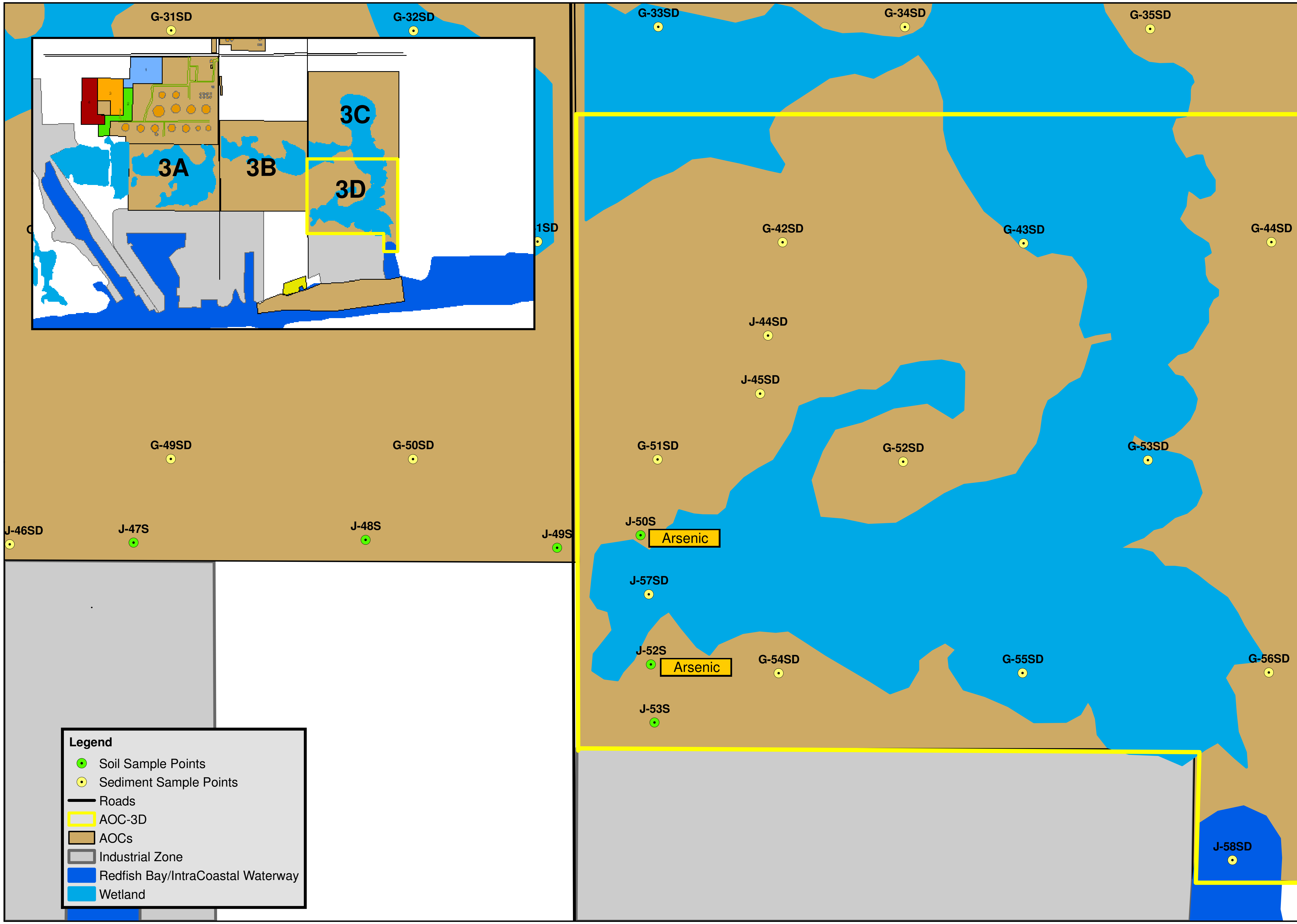
FIGURE
8B



J-50S FR-155	
Aluminum	1760
Arsenic	0.72 B
Barium	16.6 B
Beryllium	0.074 B
Chromium	1.4
Cobalt	0.36 B
Copper	2.5 B
Iron	1160
Lead	3.3
Manganese	226
Mercury	0.008 B
Nickel	0.59 B
Vanadium	2.5 B
Zinc	23.9

J-52S FR-138	
Aluminum	4590
Arsenic	1 B
Barium	37.9
Beryllium	0.23 B
Chromium	3.6
Cobalt	0.92 B
Copper	4.2
Iron	2450
Lead	4.5
Manganese	100
Mercury	0.008 B
Nickel	2.1 B
Vanadium	6.1 B
Zinc	32.8

J-53S FR-136	
Aluminum	3420
Arsenic	2.5
Barium	74.4
Beryllium	0.21 B
Chromium	5.9
Cobalt	0.93 B
Copper	3.9
Iron	3050
Lead	13.5
Manganese	113
Mercury	0.0049 B
Nickel	2.5 B
Vanadium	6.3
Zinc	279

Notes:

1. Results are posted in mg/kg

Exceeds EPA Region 6 MSSL

2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

N

0 100 200

Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-3D
Human Health
Metal Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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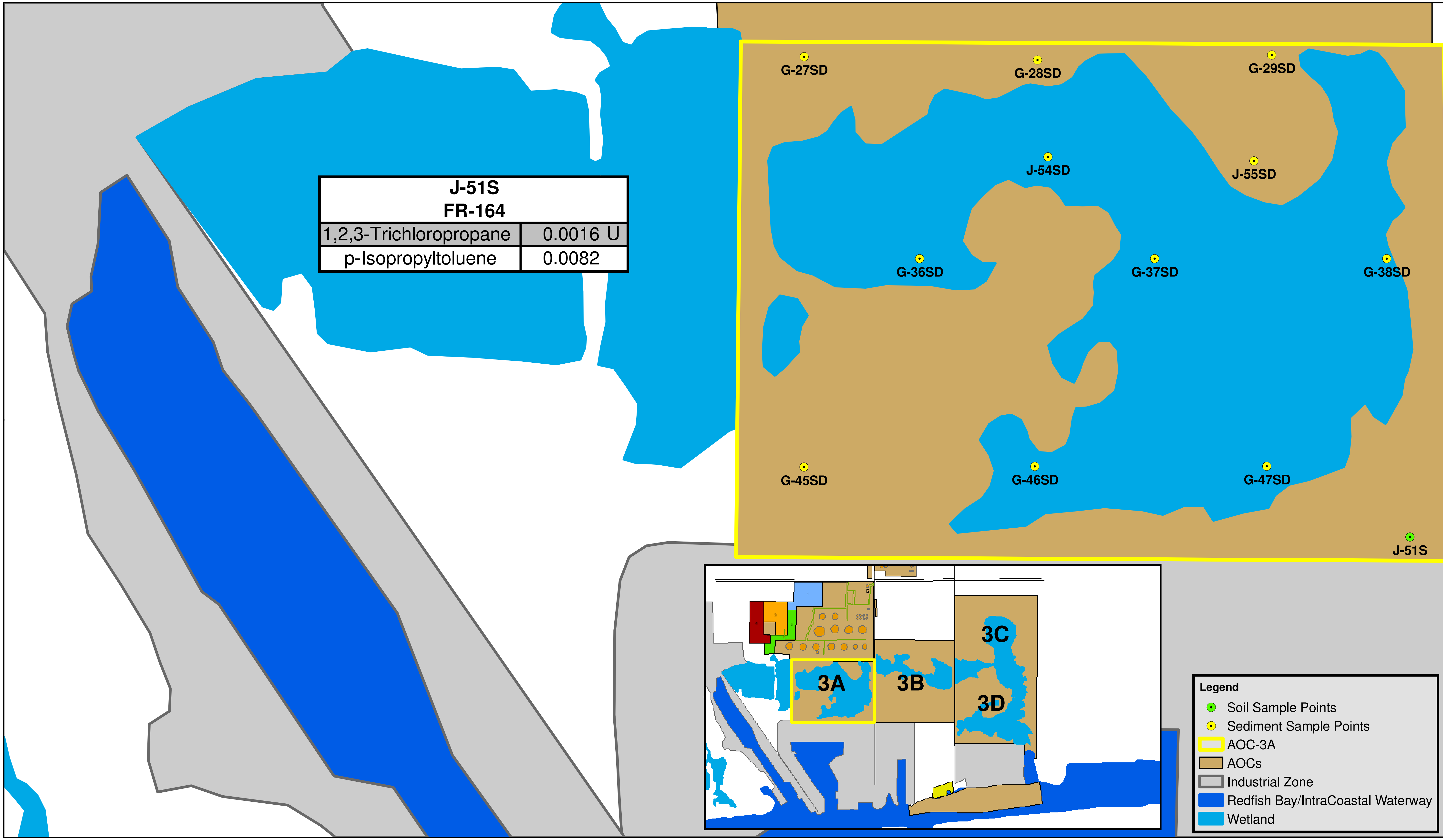
FIGURE
8C



Notes:

1. Results are posted in mg/kg
2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

SDL Exceeds TCEQ Screening Level

N

0 150 300

Feet

DATE DRAWN:	DATE REVISED:
7/8/08	4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-3A
Human Health
VOC Surface Soil Distribution Map

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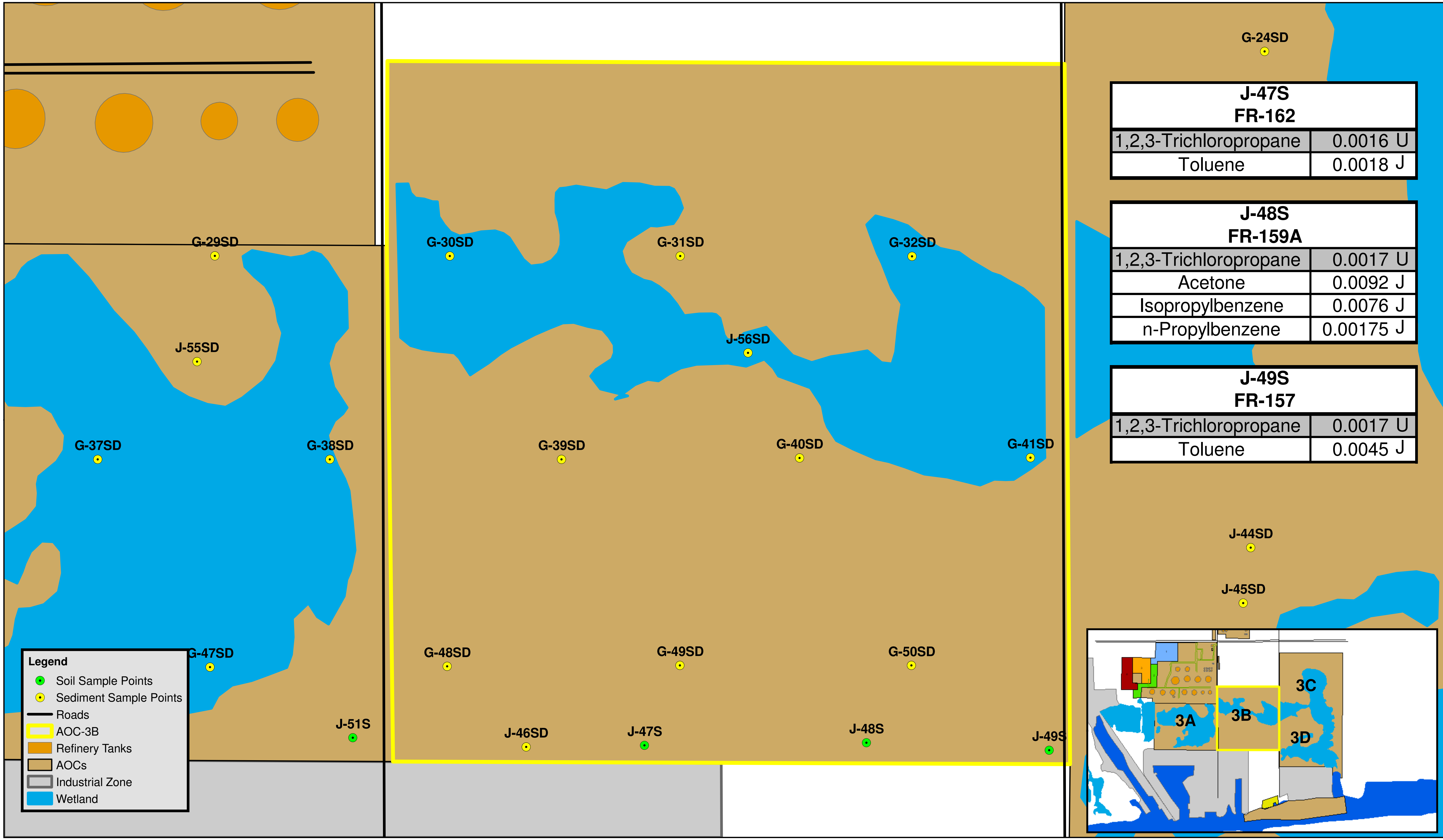
FIGURE
8D



J-47S FR-162	
1,2,3-Trichloropropane	0.0016 U
Toluene	0.0018 J

J-48S FR-159A	
1,2,3-Trichloropropane	0.0017 U
Acetone	0.0092 J
Isopropylbenzene	0.0076 J
n-Propylbenzene	0.00175 J

J-49S FR-157	
1,2,3-Trichloropropane	0.0017 U
Toluene	0.0045 J

Notes:

1. Results are posted in mg/kg
2. Qualifiers:
   - U = Undetected at the sample detection limit (SDL)
   - J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

SDL Exceeds TCEQ Screening Level

N

0 150 300

Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-3B
Human Health
VOC Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 | FILE NAME: Falcon Refinery Base Map

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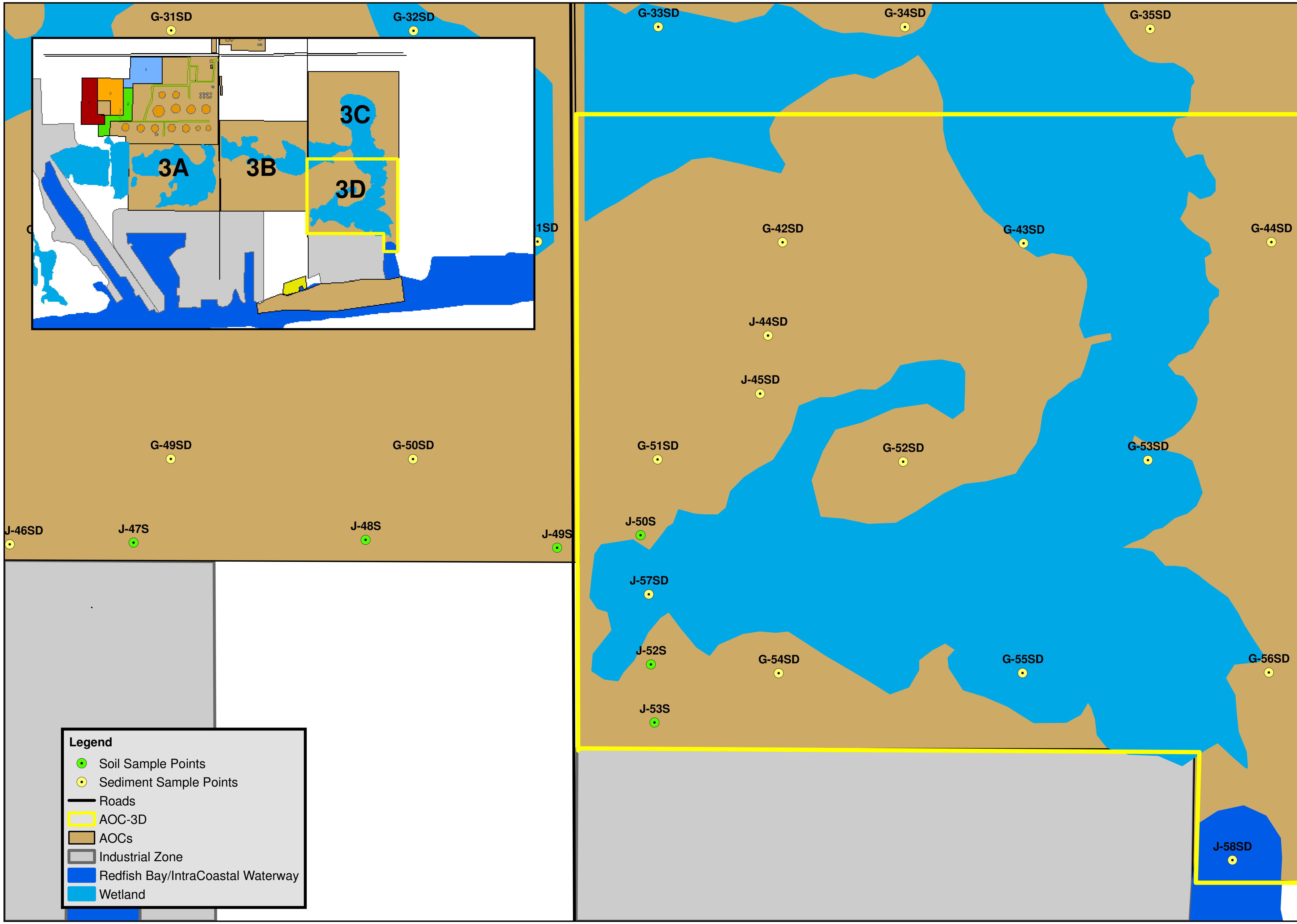
FIGURE
8E



J-50S FR-155	
1,2,3-Trichloropropane	0.0017 U
Toluene	0.0021 J

J-52S FR-138	
1,2,3-Trichloropropane	0.002 U
p-Isopropyltoluene	0.0019 J

J-53S FR-136	
1,2,3-Trichloropropane	0.0017 U
Methylene chloride	0.0052 J

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

SDL Exceeds TCEQ Screening Level

N

0 110 220

Feet

DATE DRAWN:	DATE REVISED:
2/25/09	4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-3D
Human Health
VOC Surface Soil Distribution Map

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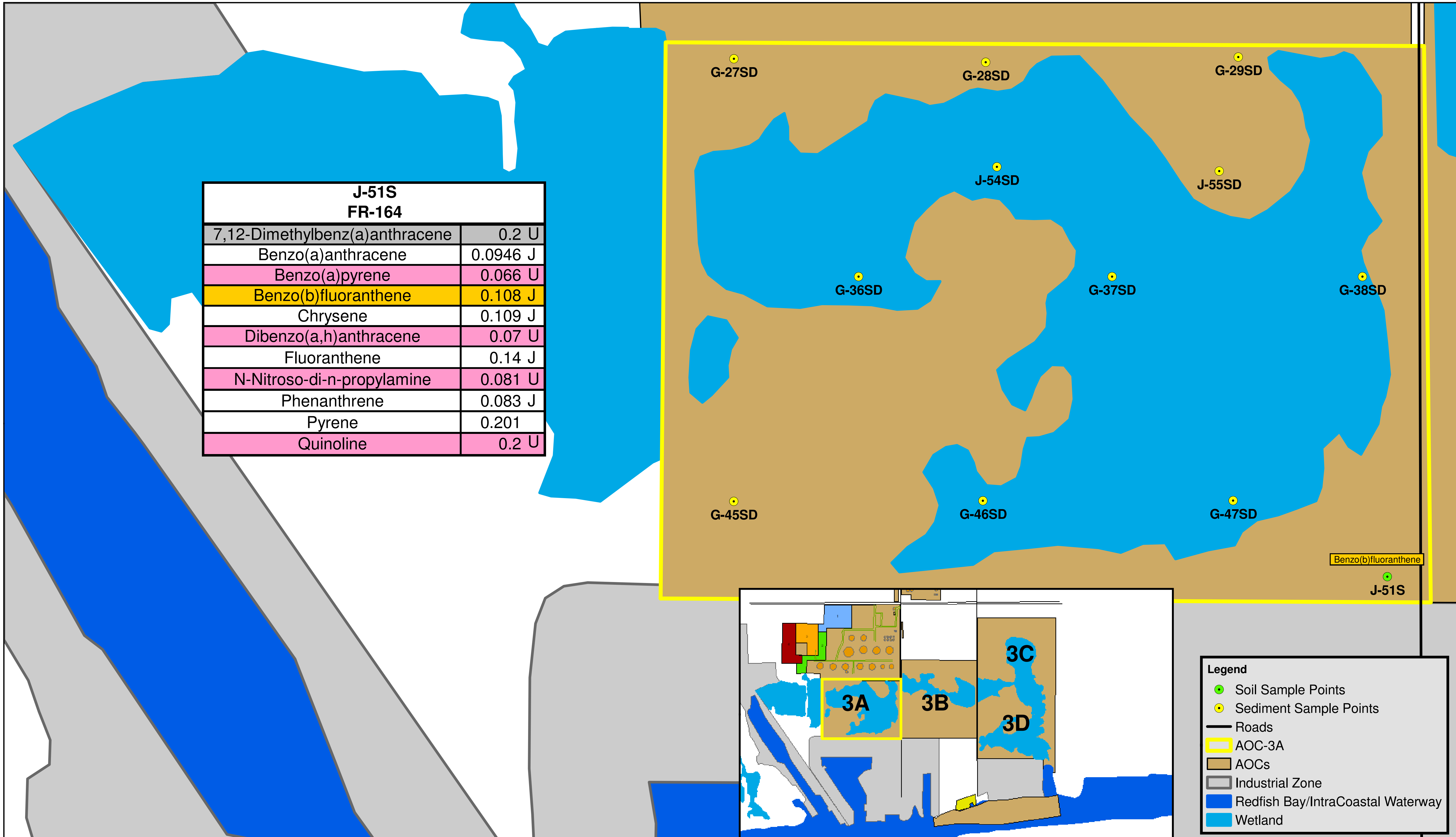
FIGURE

8F



J-51S FR-164	
7,12-Dimethylbenz(a)anthracene	0.2 U
Benzo(a)anthracene	0.0946 J
Benzo(a)pyrene	0.066 U
Benzo(b)fluoranthene	0.108 J
Chrysene	0.109 J
Dibenzo(a,h)anthracene	0.07 U
Fluoranthene	0.14 J
N-Nitroso-di-n-propylamine	0.081 U
Phenanthrene	0.083 J
Pyrene	0.201
Quinoline	0.2 U

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

Exceeds EPA Region 6 MSSL

SDL Exceeds EPA Screening Level

SDL Exceeds TCEQ Screening Level

0 140 280

Feet

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APPROVED BY:	

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Human Health
SVOC Surface Soil Distribution Map

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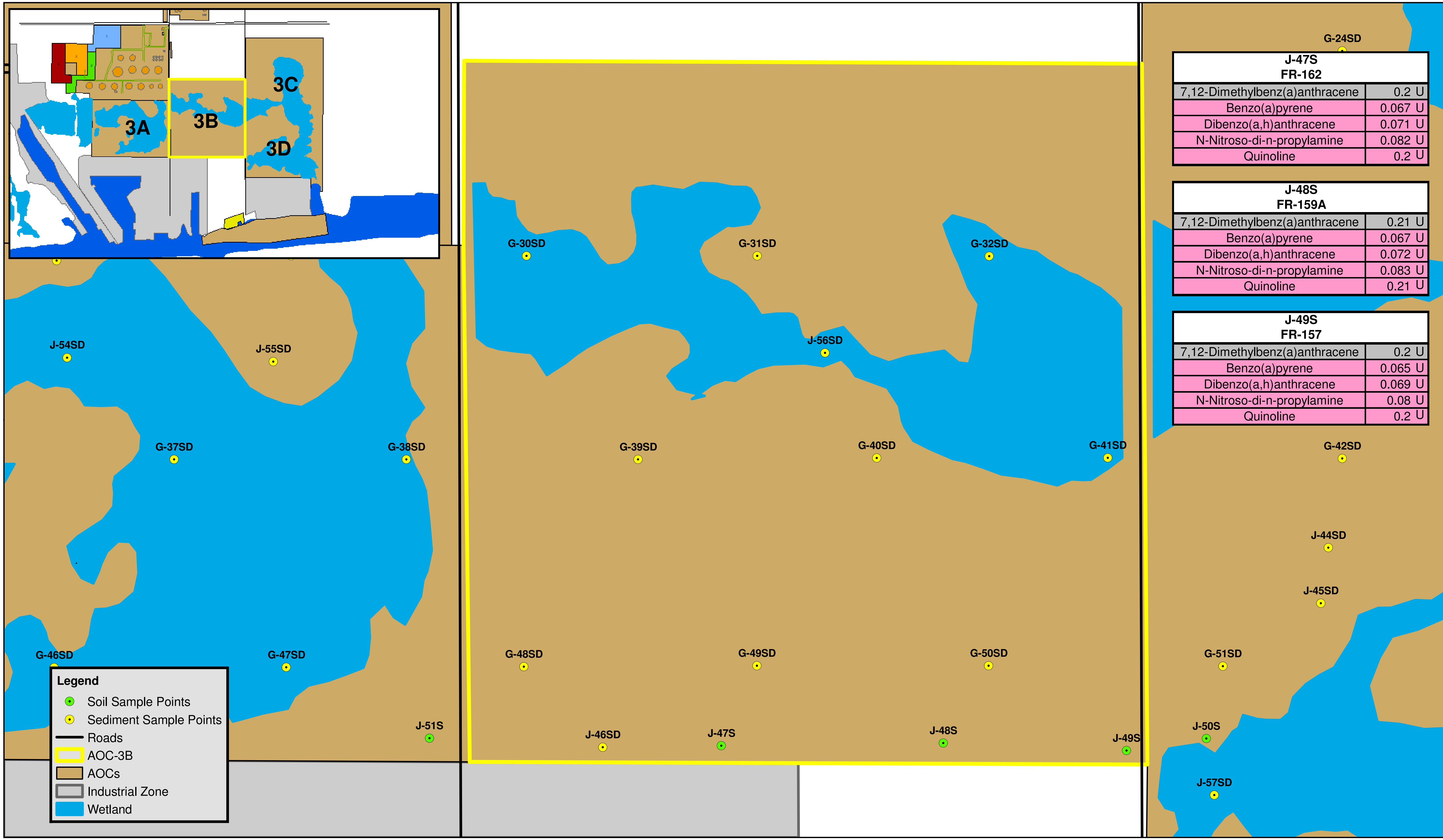
FIGURE
8G



J-47S FR-162	
7,12-Dimethylbenz(a)anthracene	0.2 U
Benzo(a)pyrene	0.067 U
Dibenzo(a,h)anthracene	0.071 U
N-Nitroso-di-n-propylamine	0.082 U
Quinoline	0.2 U

J-48S FR-159A	
7,12-Dimethylbenz(a)anthracene	0.21 U
Benzo(a)pyrene	0.067 U
Dibenzo(a,h)anthracene	0.072 U
N-Nitroso-di-n-propylamine	0.083 U
Quinoline	0.21 U

J-49S FR-157	
7,12-Dimethylbenz(a)anthracene	0.2 U
Benzo(a)pyrene	0.065 U
Dibenzo(a,h)anthracene	0.069 U
N-Nitroso-di-n-propylamine	0.08 U
Quinoline	0.2 U

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

SDL Exceeds EPA Screening Level

SDL Exceeds TCEQ Screening Level

0 150 300

Feet

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AOC-3B
Human Health
SVOC Surface Soil Distribution Map

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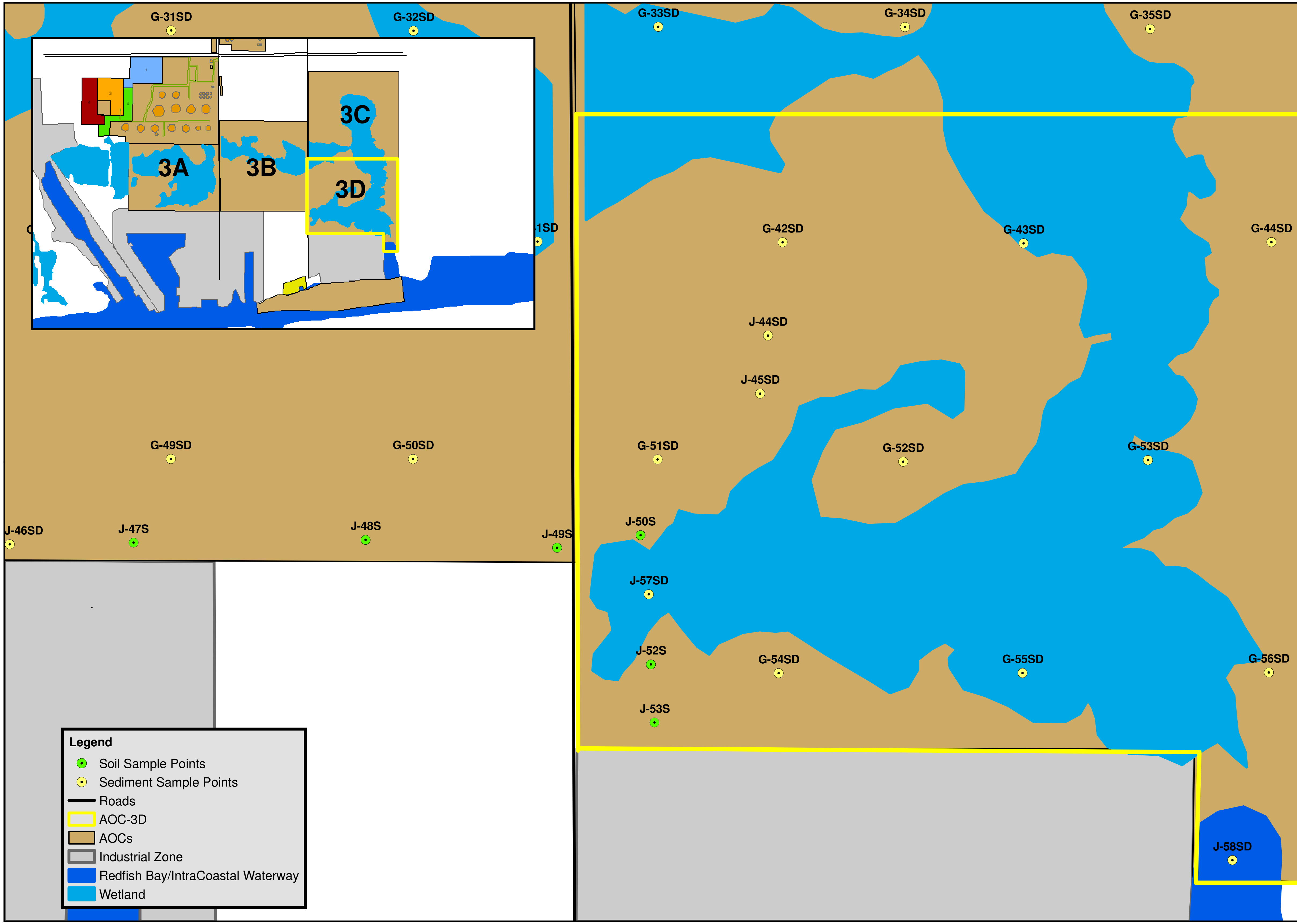
FIGURE
8H



J-50S FR-155	
7,12-Dimethylbenz(a)anthracene	0.21 U
Benzo(a)pyrene	0.068 U
Dibenzo(a,h)anthracene	0.072 U
N-Nitroso-di-n-propylamine	0.084 U
Quinoline	0.21 U

J-52S FR-138	
7,12-Dimethylbenz(a)anthracene	0.24 U
Benzo(a)pyrene	0.078 U
Dibenzo(a,h)anthracene	0.083 U
N-Nitroso-di-n-propylamine	0.096 U
Quinoline	0.24 U

J-53S FR-136	
7,12-Dimethylbenz(a)anthracene	0.2 U
Benzo(a)pyrene	0.066 U
Dibenzo(a,h)anthracene	0.071 U
N-Nitroso-di-n-propylamine	0.081 U
Quinoline	0.2 U

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

SDL Exceeds EPA Screening Level

SDL Exceeds TCEQ Screening Level

N

0 150 300

Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
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CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-3D Human Health SVOC Surface Soil Distribution Map

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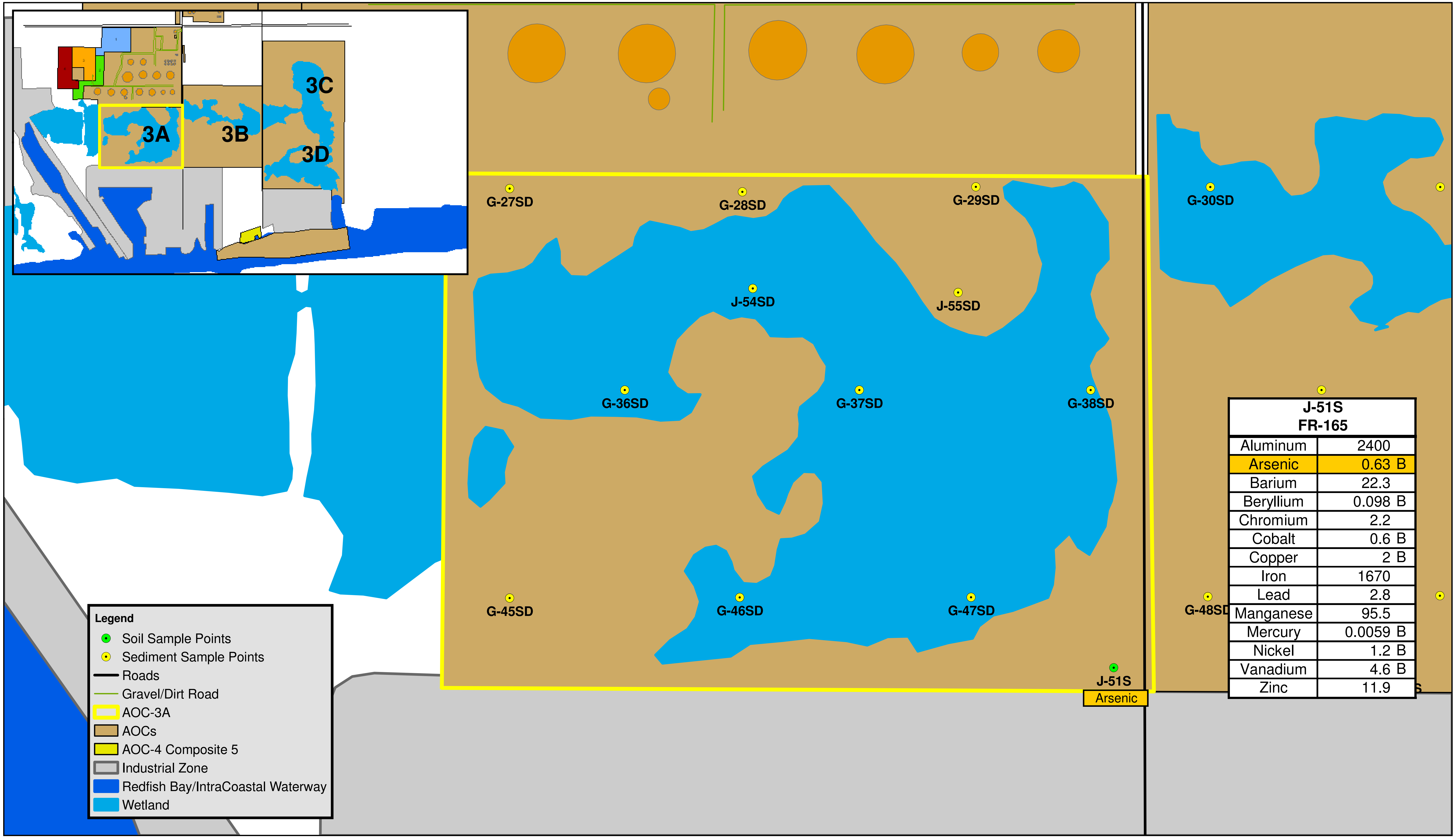
FIGURE

8I



J-51S FR-165	
Aluminum	2400
Arsenic	0.63 B
Barium	22.3
Beryllium	0.098 B
Chromium	2.2
Cobalt	0.6 B
Copper	2 B
Iron	1670
Lead	2.8
Manganese	95.5
Mercury	0.0059 B
Nickel	1.2 B
Vanadium	4.6 B
Zinc	11.9

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds EPA Region 6 MSSL

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AOC-3A
Human Health
Metal Subsurface Soil Distribution Map

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FIGURE
9A

J-47S FR-163	
Aluminum	3290
Arsenic	1.3
Barium	45.7
Beryllium	0.14 B
Chromium	2.7
Cobalt	1.1 B
Copper	1.9 B
Iron	2250
Lead	3.1
Manganese	41.4
Mercury	0.034
Nickel	1.4 B
Vanadium	4.4 B
Zinc	35.8

J-48S FR-161	
Aluminum	4210
Arsenic	1.2
Barium	24.3
Beryllium	0.18 B
Chromium	3.4
Cobalt	0.63 B
Copper	1.3 B
Iron	2750
Lead	3.1
Manganese	26.9
Mercury	0.012 B
Nickel	1.2 B
Vanadium	5.5 B
Zinc	10.2

J-49S FR-158	
Aluminum	3070
Arsenic	0.69 B
Barium	209
Beryllium	0.13 B
Chromium	3.6
Hex Chrom	1.4 B
Cobalt	0.81 B
Copper	5
Iron	2900
Lead	4.3
Manganese	42.2
Mercury	0.033
Nickel	1.6 B
Vanadium	4.5 B
Zinc	18.2

Notes:

1. Results are posted in mg/kg

2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds EPA Region 6 MSSL

0 100 200

Feet

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APPROVED BY:	

AOC-3B
Human Health
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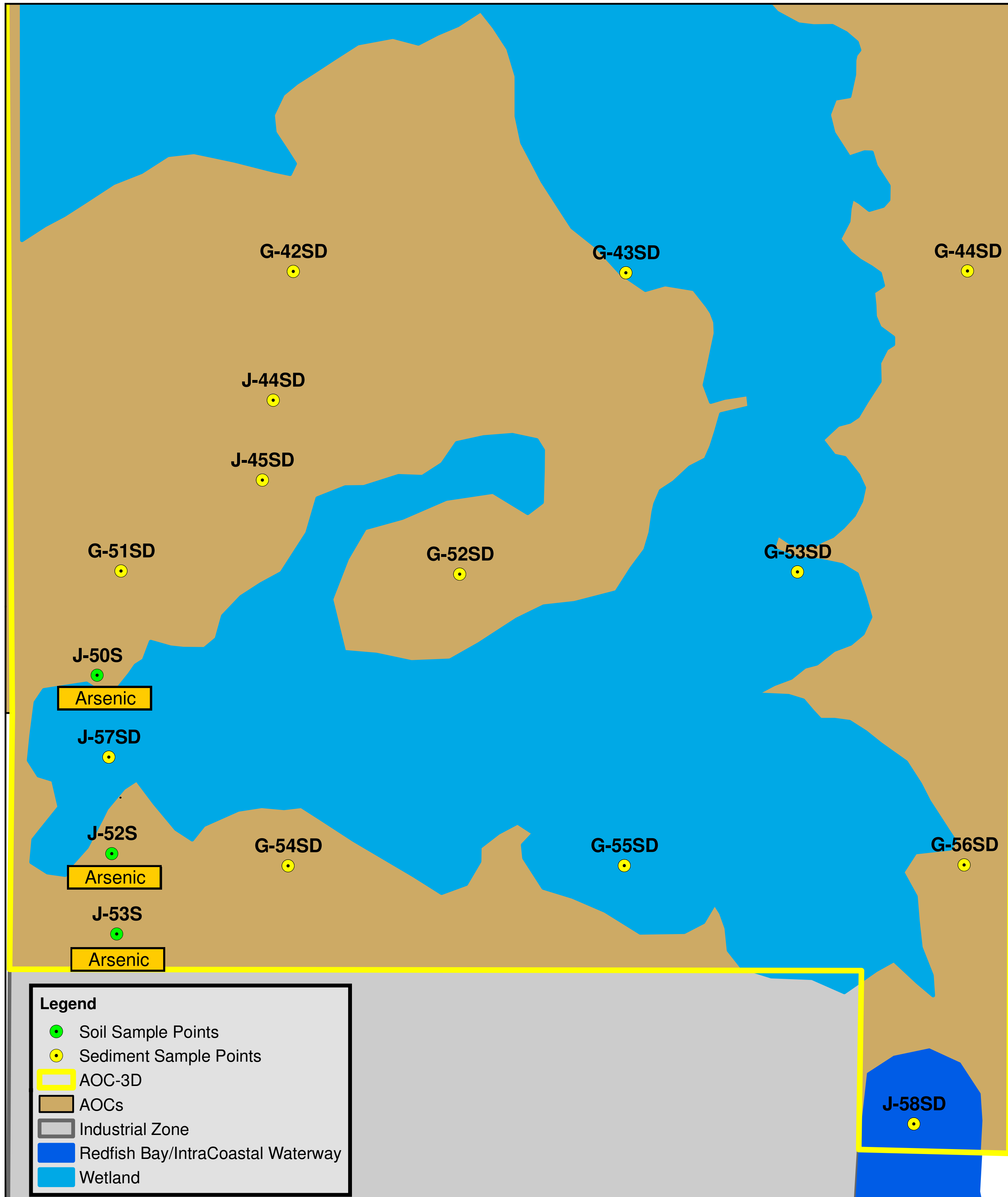
FIGURE

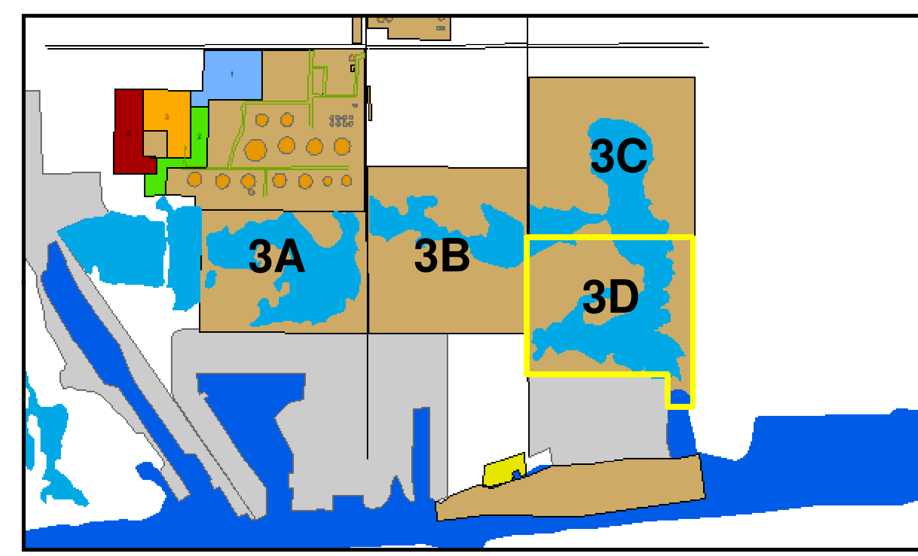
9B



J-50S FR-156	
Aluminum	4600
Arsenic	0.52 B
Barium	45.5
Beryllium	0.19 B
Chromium	3.2
Cobalt	1.1 B
Copper	2.6 B
Iron	3060
Lead	2.7
Manganese	76.3
Mercury	0.0065 B
Nickel	1.8 B
Vanadium	5.1 B
Zinc	13.7

J-53S FR-137	
Aluminum	4260
Arsenic	2.4
Barium	17.9 B
Beryllium	0.2 B
Chromium	3.9
Cobalt	0.88 B
Copper	2.3 B
Iron	2680
Lead	2.5
Manganese	113
Mercury	0.002 B
Nickel	2.3 B
Vanadium	7.9
Zinc	17.5

J-52S FR-139	
Aluminum	3570
Arsenic	1.1 B
Barium	21.6 B
Beryllium	0.19 B
Chromium	4
Cobalt	0.8 B
Copper	2 B
Iron	2300
Lead	2.4
Manganese	114
Mercury	0.0023 B
Nickel	1.9 B
Vanadium	5.3 B
Zinc	8.9



Notes:

1. Results are posted in mg/kg

2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds EPA Region 6 MSSL

N

0 100 200
Feet

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APPROVED BY:	

AOC-3D
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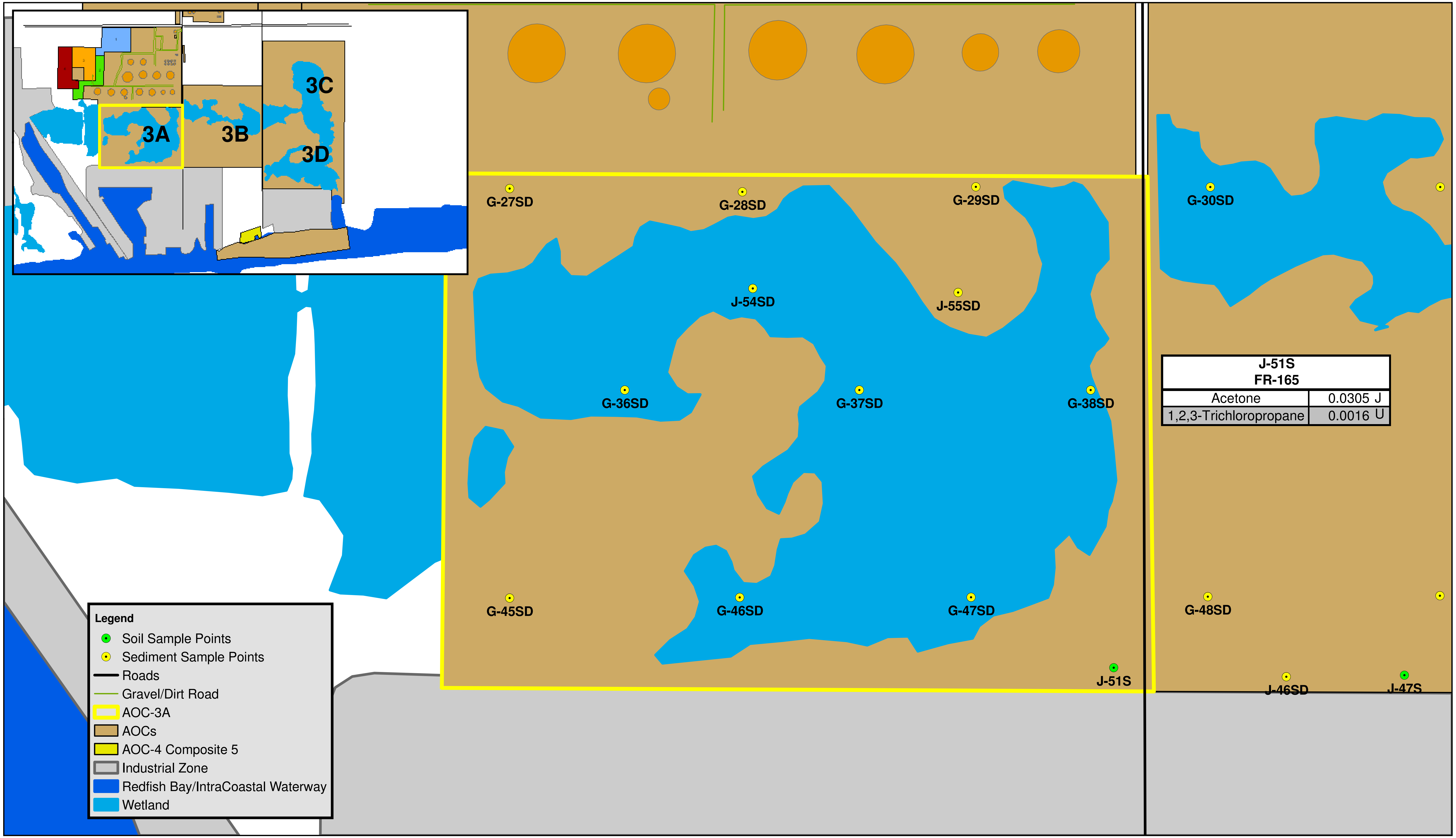
FIGURE
9C



Notes:

1. Results are posted in mg/kg

2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

SDL Exceeds TCEQ Screening Level

N

0 100 200

Feet

DATE DRAWN: 2/25/09	DATE REVISED: 4/1/09
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APPROVED BY:	

AOC-3A
Human Health
VOC Subsurface Soil Distribution Map

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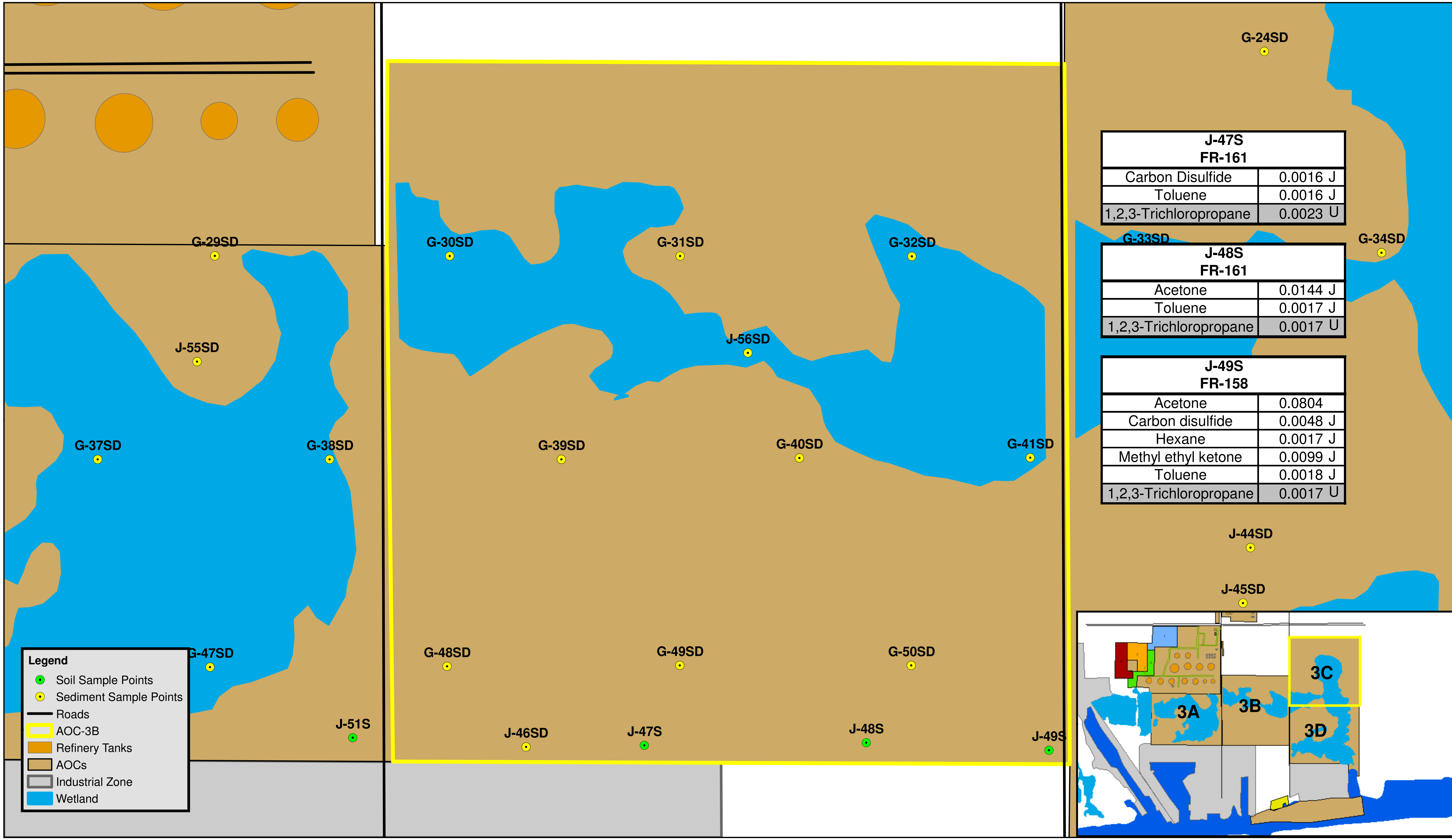
FIGURE
9D



J-47S FR-161	
Carbon Disulfide	0.0016 J
Toluene	0.0016 J
1,2,3-Trichloropropane	0.0023 U

J-48S FR-161	
Acetone	0.0144 J
Toluene	0.0017 J
1,2,3-Trichloropropane	0.0017 U

J-49S FR-158	
Acetone	0.0804
Carbon disulfide	0.0048 J
Hexane	0.0017 J
Methyl ethyl ketone	0.0099 J
Toluene	0.0018 J
1,2,3-Trichloropropane	0.0017 U

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

SDL Exceeds TCEQ Screening Level

N

0 150 300

Feet

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APPROVED BY:	

AOC-3B
Human Health
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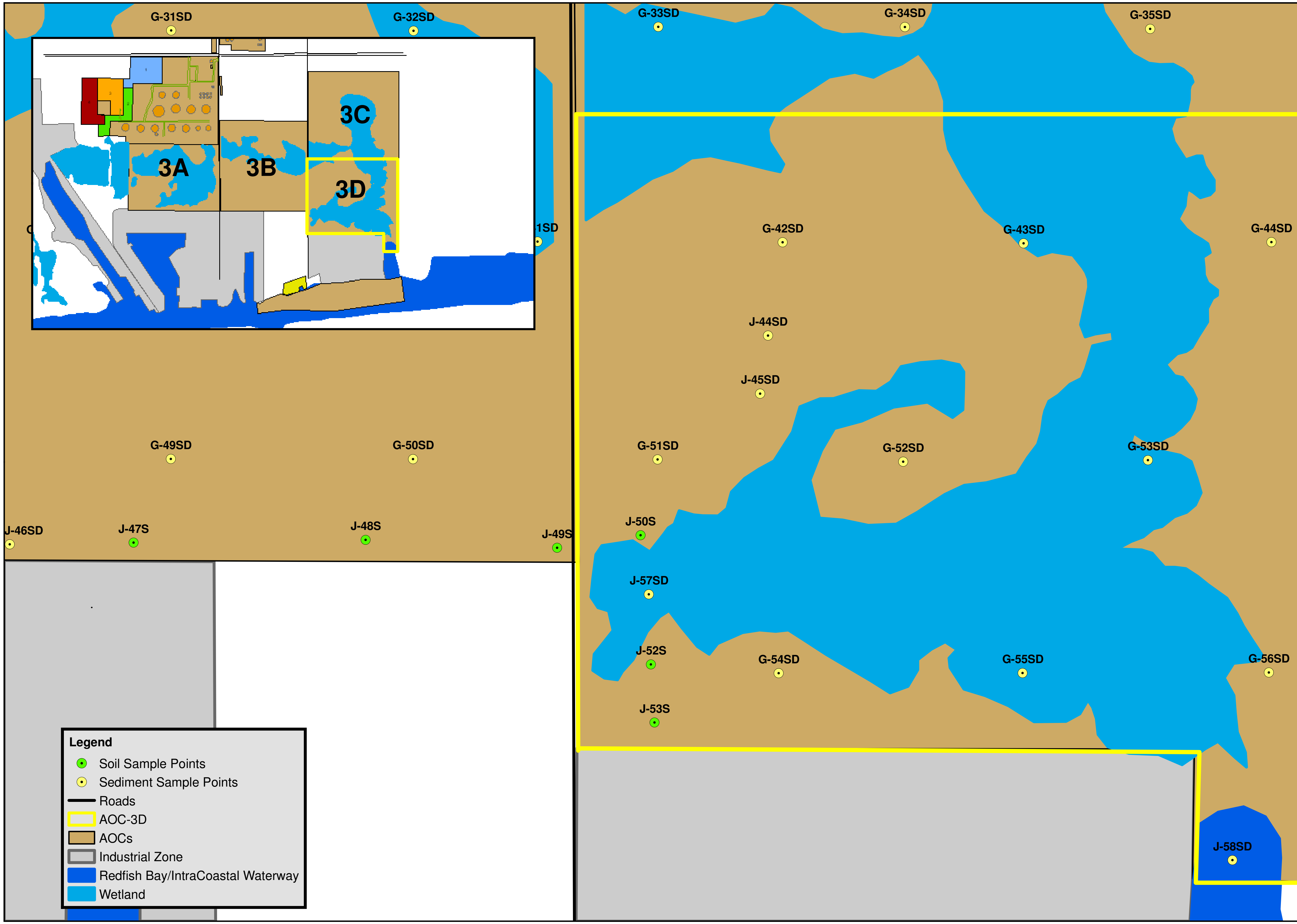
FIGURE

9E



J-50S FR-156	
Acetone	0.0164 J
Toluene	0.0017 J
1,2,3-Trichloropropane	0.0017 U

J-52S FR-139	
Acetone	0.0165 J
Carbon disulfide	0.0023 J
1,2,3-Trichloropropane	0.0017 U

J-53S FR-137	
Acetone	0.0094 J
1,2,3-Trichloropropane	0.0016 U

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

SDL Exceeds TCEQ Screening Level

N

0 110 220

Feet

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APPROVED BY:	

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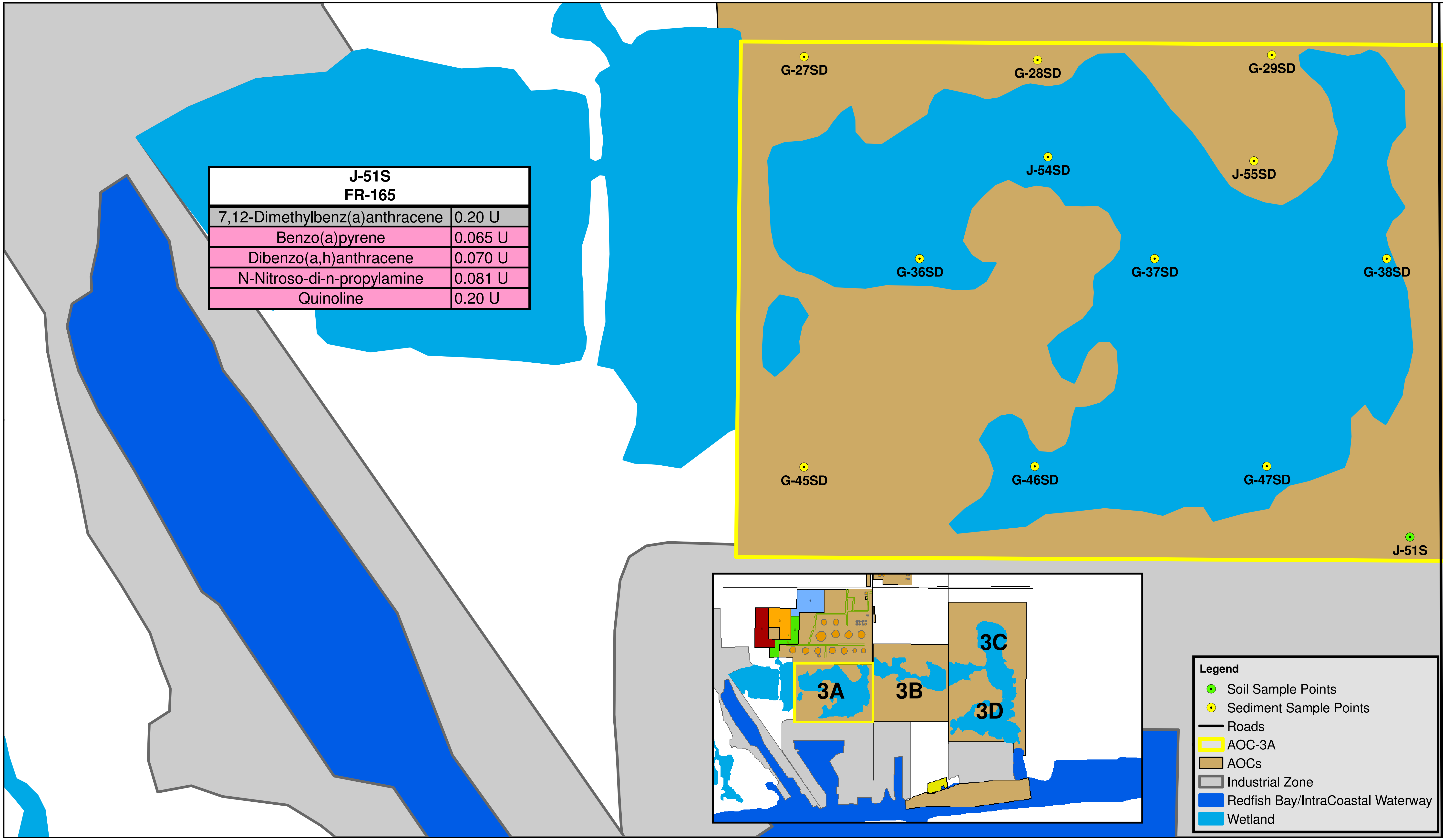
FIGURE
9F



J-51S FR-165	
7,12-Dimethylbenz(a)anthracene	0.20 U
Benzo(a)pyrene	0.065 U
Dibenzo(a,h)anthracene	0.070 U
N-Nitroso-di-n-propylamine	0.081 U
Quinoline	0.20 U

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

SDL Exceeds EPA Screening Level

SDL Exceeds TCEQ Screening Level

N

0 150 300

Feet

DATE DRAWN:	DATE REVISED:
7/8/08	4/1/09
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CHECKED BY:	S. HALASZ
APPROVED BY:	

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Human Health
SVOC Subsurface Soil Distribution Map

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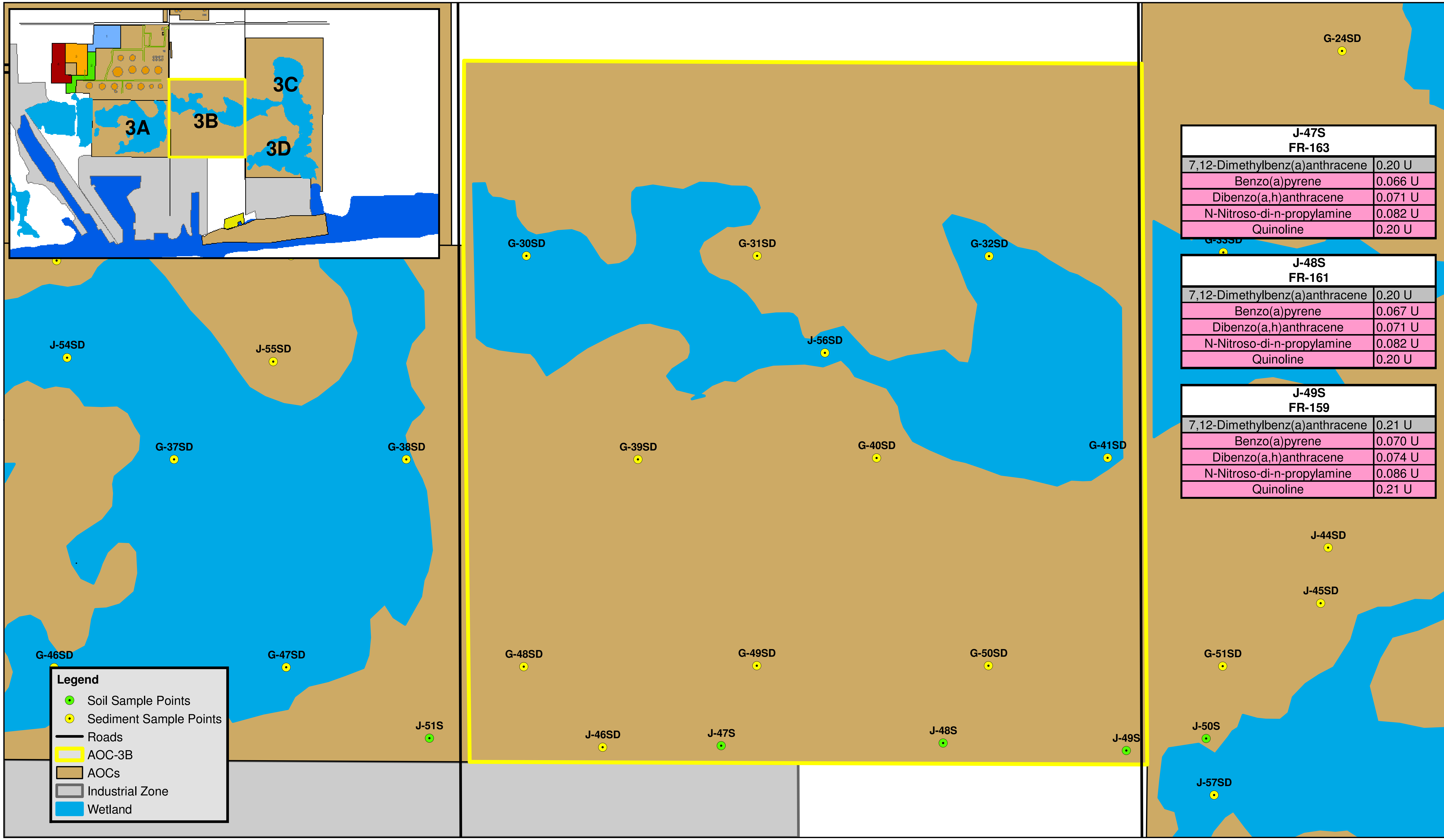
FIGURE
9G



J-47S FR-163	
7,12-Dimethylbenz(a)anthracene	0.20 U
Benzo(a)pyrene	0.066 U
Dibenzo(a,h)anthracene	0.071 U
N-Nitroso-di-n-propylamine	0.082 U
Quinoline	0.20 U

J-48S FR-161	
7,12-Dimethylbenz(a)anthracene	0.20 U
Benzo(a)pyrene	0.067 U
Dibenzo(a,h)anthracene	0.071 U
N-Nitroso-di-n-propylamine	0.082 U
Quinoline	0.20 U

J-49S FR-159	
7,12-Dimethylbenz(a)anthracene	0.21 U
Benzo(a)pyrene	0.070 U
Dibenzo(a,h)anthracene	0.074 U
N-Nitroso-di-n-propylamine	0.086 U
Quinoline	0.21 U

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

SDL Exceeds EPA Screening Level

SDL Exceeds TCEQ Screening Level

0 150 300

Feet

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APPROVED BY:	

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SVOC Subsurface Soil Distribution Map

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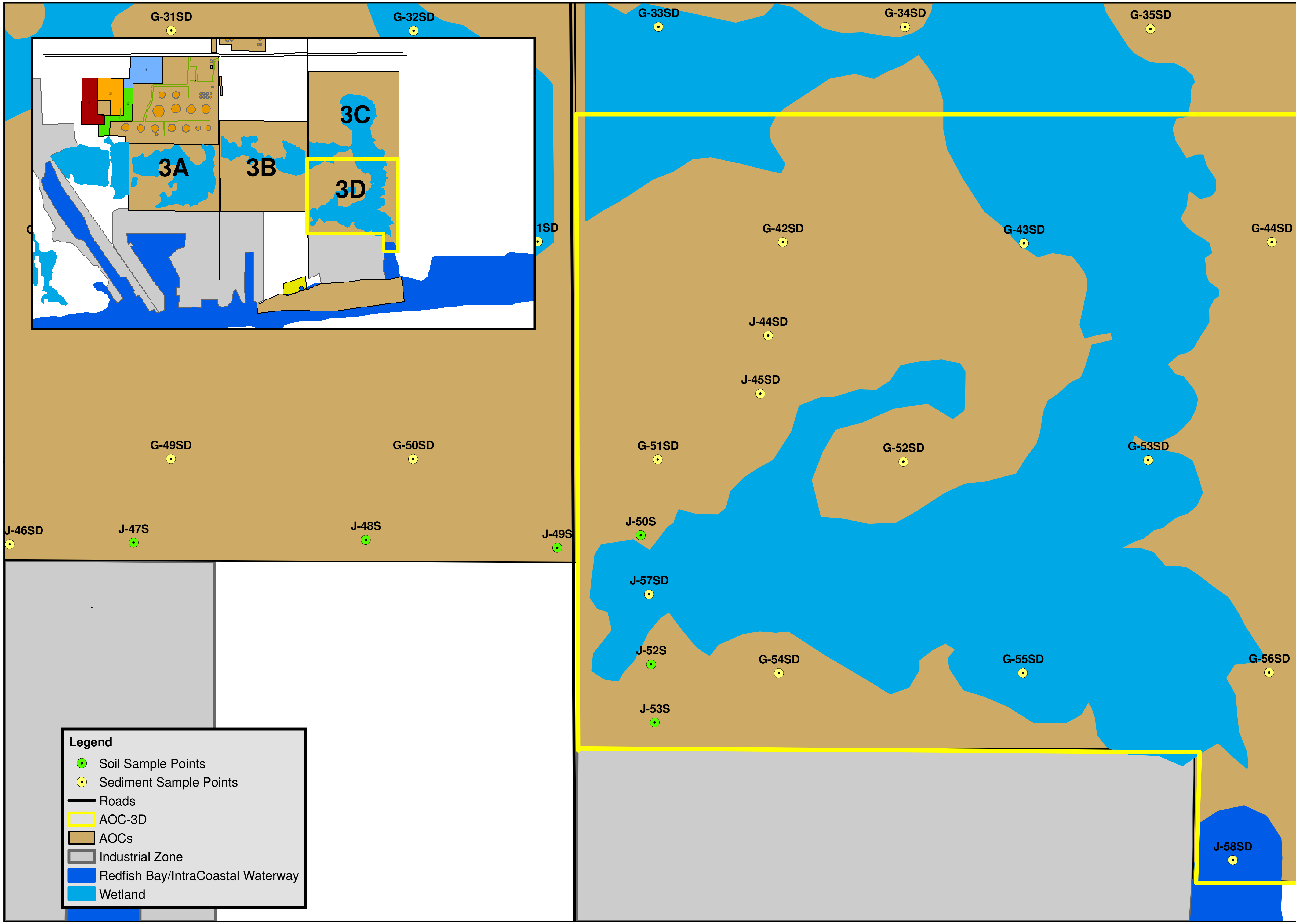
FIGURE
9H



J-50S FR-156	
7,12-Dimethylbenz(a)anthracene	0.20 U
Benzo(a)pyrene	0.066 U
Dibenzo(a,h)anthracene	0.071 U
N-Nitroso-di-n-propylamine	0.082 U
Quinoline	0.20 U

J-52S FR-139	
7,12-Dimethylbenz(a)anthracene	0.20 U
Benzo(a)pyrene	0.067 U
Dibenzo(a,h)anthracene	0.071 U
N-Nitroso-di-n-propylamine	0.082 U
Quinoline	0.20 U

J-53S FR-137	
7,12-Dimethylbenz(a)anthracene	0.20 U
Benzo(a)pyrene	0.066 U
Dibenzo(a,h)anthracene	0.070 U
N-Nitroso-di-n-propylamine	0.081 U
Quinoline	0.20 U

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

SDL Exceeds EPA Screening Level

SDL Exceeds TCEQ Screening Level

0 150 300

Feet

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APPROVED BY:	

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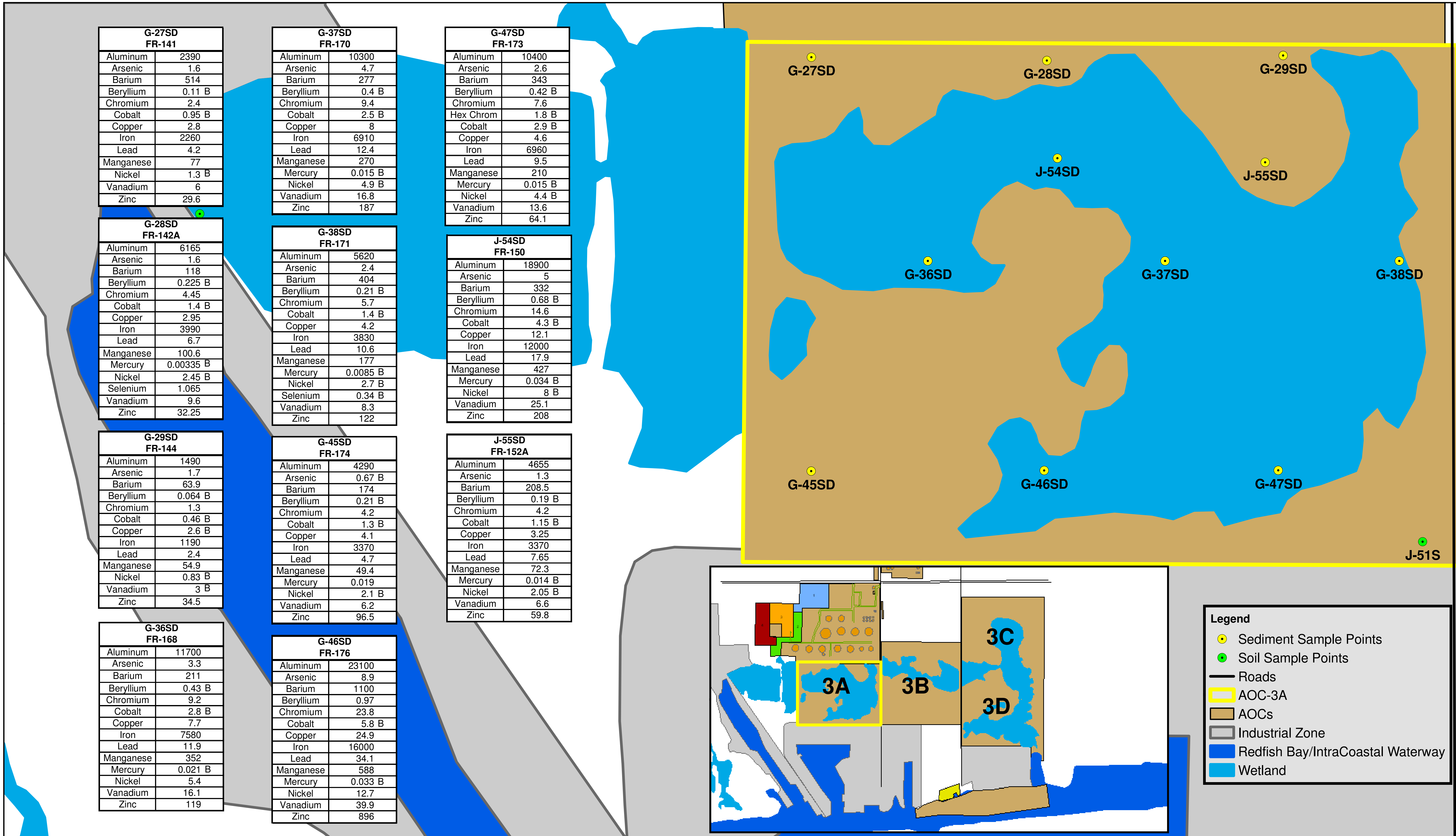
FIGURE

9I



G-27SD FR-141	
Aluminum	2390
Arsenic	1.6
Barium	514
Beryllium	0.11 B
Chromium	2.4
Cobalt	0.95 B
Copper	2.8
Iron	2260
Lead	4.2
Manganese	77
Nickel	1.3 B
Vanadium	6
Zinc	29.6

G-28SD FR-142A	
Aluminum	6165
Arsenic	1.6
Barium	118
Beryllium	0.225 B
Chromium	4.45
Cobalt	1.4 B
Copper	2.95
Iron	3990
Lead	6.7
Manganese	100.6
Mercury	0.00335 B
Nickel	2.45 B
Selenium	1.065
Vanadium	9.6
Zinc	32.25

G-29SD FR-144	
Aluminum	1490
Arsenic	1.7
Barium	63.9
Beryllium	0.064 B
Chromium	1.3
Cobalt	0.46 B
Copper	2.6 B
Iron	1190
Lead	2.4
Manganese	54.9
Nickel	0.83 B
Vanadium	3 B
Zinc	34.5

G-36SD FR-168	
Aluminum	11700
Arsenic	3.3
Barium	211
Beryllium	0.43 B
Chromium	9.2
Cobalt	2.8 B
Copper	7.7
Iron	7580
Lead	11.9
Manganese	352
Mercury	0.021 B
Nickel	5.4
Vanadium	16.1
Zinc	119

G-37SD FR-170	
Aluminum	10300
Arsenic	4.7
Barium	277
Beryllium	0.4 B
Chromium	9.4
Cobalt	2.5 B
Copper	8
Iron	6910
Lead	12.4
Manganese	270
Mercury	0.015 B
Nickel	4.9 B
Vanadium	16.8
Zinc	187

G-38SD FR-171	
Aluminum	5620
Arsenic	2.4
Barium	404
Beryllium	0.21 B
Chromium	5.7
Cobalt	1.4 B
Copper	4.2
Iron	3830
Lead	10.6
Manganese	177
Mercury	0.0085 B
Nickel	2.7 B
Selenium	0.34 B
Vanadium	8.3
Zinc	122

G-45SD FR-174	
Aluminum	4290
Arsenic	0.67 B
Barium	174
Beryllium	0.21 B
Chromium	4.2
Cobalt	1.3 B
Copper	4.1
Iron	3370
Lead	4.7
Manganese	49.4
Mercury	0.019
Nickel	2.1 B
Vanadium	6.2
Zinc	96.5

G-46SD FR-176	
Aluminum	23100
Arsenic	8.9
Barium	1100
Beryllium	0.97
Chromium	23.8
Cobalt	5.8 B
Copper	24.9
Iron	16000
Lead	34.1
Manganese	588
Mercury	0.033 B
Nickel	12.7
Vanadium	39.9
Zinc	896

G-47SD FR-173	
Aluminum	10400
Arsenic	2.6
Barium	343
Beryllium	0.42 B
Chromium	7.6
Hex Chrom	1.8 B
Cobalt	2.9 B
Copper	4.6
Iron	6960
Lead	9.5
Manganese	210
Mercury	0.015 B
Nickel	4.4 B
Vanadium	13.6
Zinc	64.1

J-54SD FR-150	
Aluminum	18900
Arsenic	5
Barium	332
Beryllium	0.68 B
Chromium	14.6
Cobalt	4.3 B
Copper	12.1
Iron	12000
Lead	17.9
Manganese	427
Mercury	0.034 B
Nickel	8 B
Vanadium	25.1
Zinc	208

J-55SD FR-152A	
Aluminum	4655
Arsenic	1.3
Barium	208.5
Beryllium	0.19 B
Chromium	4.2
Cobalt	1.15 B
Copper	3.25
Iron	3370
Lead	7.65
Manganese	72.3
Mercury	0.014 B
Nickel	2.05 B
Vanadium	6.6
Zinc	59.8

Notes:

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N

0 100 200

Feet

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CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-3A
Human Health
Metal Sediment Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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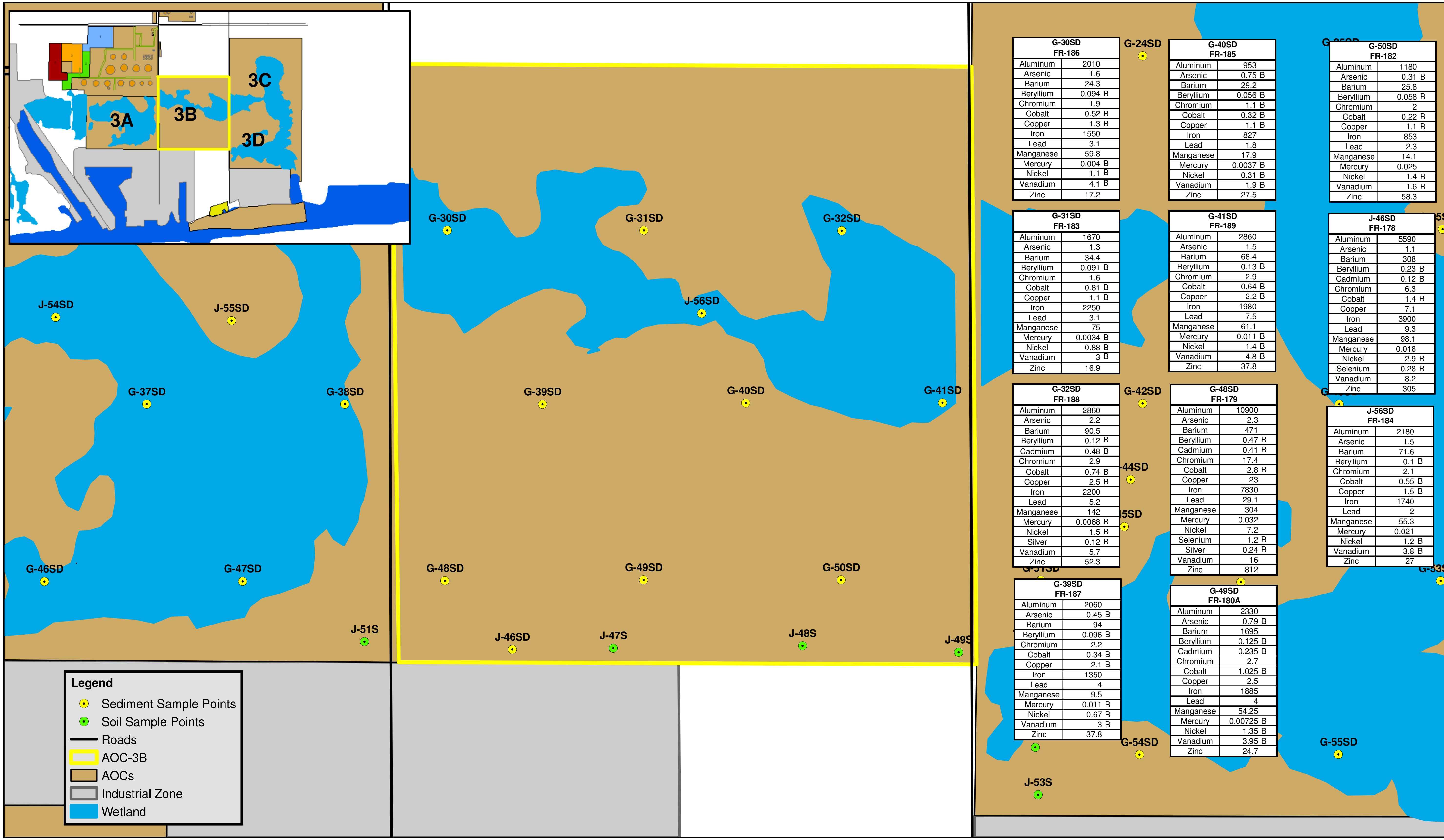
FIGURE
10A



G-30SD FR-186	
Aluminum	2010
Arsenic	1.6
Barium	24.3
Beryllium	0.094 B
Chromium	1.9
Cobalt	0.52 B
Copper	1.3 B
Iron	1550
Lead	3.1
Manganese	59.8
Mercury	0.004 B
Nickel	1.1 B
Vanadium	4.1 B
Zinc	17.2

G-40SD FR-185	
Aluminum	953
Arsenic	0.75 B
Barium	29.2
Beryllium	0.056 B
Chromium	1.1 B
Cobalt	0.32 B
Copper	1.1 B
Iron	827
Lead	1.8
Manganese	17.9
Mercury	0.0037 B
Nickel	0.31 B
Vanadium	1.9 B
Zinc	27.5

G-50SD FR-182	
Aluminum	1180
Arsenic	0.31 B
Barium	25.8
Beryllium	0.058 B
Chromium	2
Cobalt	0.22 B
Copper	1.1 B
Iron	853
Lead	2.3
Manganese	14.1
Mercury	0.025
Nickel	1.4 B
Vanadium	1.6 B
Zinc	58.3

G-31SD FR-183	
Aluminum	1670
Arsenic	1.3
Barium	34.4
Beryllium	0.091 B
Chromium	1.6
Cobalt	0.81 B
Copper	1.1 B
Iron	2250
Lead	3.1
Manganese	75
Mercury	0.0034 B
Nickel	0.88 B
Vanadium	3 B
Zinc	16.9

G-41SD FR-189	
Aluminum	2860
Arsenic	1.5
Barium	68.4
Beryllium	0.13 B
Chromium	2.9
Cobalt	0.64 B
Copper	2.2 B
Iron	1980
Lead	7.5
Manganese	61.1
Mercury	0.011 B
Nickel	1.4 B
Vanadium	4.8 B
Zinc	37.8

J-46SD FR-178	
Aluminum	5590
Arsenic	1.1
Barium	308
Beryllium	0.23 B
Cadmium	0.12 B
Chromium	6.3
Cobalt	1.4 B
Copper	7.1
Iron	3900
Lead	9.3
Manganese	98.1
Mercury	0.018
Nickel	2.9 B
Selenium	0.28 B
Vanadium	8.2
Zinc	305

G-32SD FR-188	
Aluminum	2860
Arsenic	2.2
Barium	90.5
Beryllium	0.12 B
Cadmium	0.48 B
Chromium	2.9
Cobalt	0.74 B
Copper	2.5 B
Iron	2200
Lead	5.2
Manganese	142
Mercury	0.0068 B
Nickel	1.5 B
Silver	0.12 B
Vanadium	5.7
Zinc	52.3

G-48SD FR-179	
Aluminum	10900
Arsenic	2.3
Barium	471
Beryllium	0.47 B
Cadmium	0.41 B
Chromium	17.4
Cobalt	2.8 B
Copper	23
Iron	7830
Lead	29.1
Manganese	304
Mercury	0.032
Nickel	7.2
Selenium	1.2 B
Silver	0.24 B
Vanadium	16
Zinc	812

J-56SD FR-184	
Aluminum	2180
Arsenic	1.5
Barium	71.6
Beryllium	0.1 B
Chromium	2.1
Cobalt	0.55 B
Copper	1.5 B
Iron	1740
Lead	2
Manganese	55.3
Mercury	0.021
Nickel	1.2 B
Vanadium	3.8 B
Zinc	27

G-39SD FR-187	
Aluminum	2060
Arsenic	0.45 B
Barium	94
Beryllium	0.096 B
Chromium	2.2
Cobalt	0.34 B
Copper	2.1 B
Iron	1350
Lead	4
Manganese	9.5
Mercury	0.011 B
Nickel	0.67 B
Vanadium	3 B
Zinc	37.8

G-49SD FR-180A	
Aluminum	2330
Arsenic	0.79 B
Barium	1695
Beryllium	0.125 B
Cadmium	0.235 B
Chromium	2.7
Cobalt	1.025 B
Copper	2.5
Iron	1885
Lead	4
Manganese	54.25
Mercury	0.00725 B
Nickel	1.35 B
Vanadium	3.95 B
Zinc	24.7

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APPROVED BY:	

AOC-3B
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FIGURE
10B

G-21SD FR-210	
Aluminum	971
Arsenic	0.33 B
Barium	22.8
Beryllium	0.051 B
Chromium	1.2
Cobalt	0.2 B
Copper	1.1 B
Iron	676
Lead	9.1
Manganese	21.7
Mercury	0.0081 B
Nickel	0.72 B
Silver	0.093 B
Vanadium	1.2 B
Zinc	134

G-22SD FR-209	
Aluminum	34700
Arsenic	17.3
Barium	95.2 B
Beryllium	1.3 B
Cadmium	0.67 B
Chromium	29.9
Cobalt	10.4 B
Copper	57.1
Iron	23200
Lead	30.5
Manganese	171
Mercury	0.11
Nickel	23.5
Selenium	2.2 B
Silver	1.3 B
Vanadium	58.9
Zinc	611

G-23SD FR-208	
Aluminum	35900
Arsenic	6.3
Barium	310
Beryllium	1.4
Cadmium	0.32 B
Chromium	28.9
Cobalt	9
Copper	21.2
Iron	23700
Lead	18.1
Manganese	398
Mercury	0.046
Nickel	18.1
Selenium	1 B
Silver	1.1 B
Vanadium	48.2
Zinc	207

G-24SD FR-204	
Aluminum	2600
Arsenic	1.4
Barium	47.4
Beryllium	0.14 B
Chromium	2.4
Cobalt	1.1 B
Copper	3.3
Iron	2120
Lead	4.9
Manganese	79.6
Mercury	0.0021 B
Nickel	1.8 B
Vanadium	4.8 B
Zinc	53.4

G-25SD FR-205	
Aluminum	5490
Arsenic	2.4
Barium	45.1
Beryllium	0.22 B
Chromium	4.7
Cobalt	1.6 B
Copper	5.3
Iron	3870
Lead	6.2
Manganese	162
Mercury	0.0097 B
Nickel	3.1 B
Silver	0.27 B
Vanadium	8.5
Zinc	68.2

G-26SD FR-206A	
Aluminum	6525
Arsenic	2.13 B
Barium	133.15
Beryllium	0.2565 B
Cadmium	0.21 B
Chromium	7.55
Cobalt	1.72 B
Copper	15.85 B
Iron	5635
Lead	6.55
Manganese	240.85
Mercury	0.0072 B
Nickel	8.735 B
Selenium	0.445 B
Silver	0.175 B
Vanadium	10.25
Zinc	257.6

G-33SD FR-190	
Aluminum	3810
Arsenic	2.8
Barium	72.4
Beryllium	0.15 B
Chromium	3.5
Cobalt	0.93 B
Copper	4.4
Iron	2780
Lead	14
Manganese	95.9
Mercury	0.0071 B
Nickel	2.1 B
Vanadium	6.4
Zinc	91.2

G-34SD FR-191	
Aluminum	4560
Arsenic	0.86 B
Barium	7.8 B
Beryllium	0.19 B
Chromium	3.3
Cobalt	0.91 B
Copper	1.1 B
Iron	2880
Lead	2.5
Manganese	32.2
Mercury	0.0029 B
Nickel	1.3 B
Vanadium	5.1 B
Zinc	11.2

G-35SD FR-192	
Aluminum	2220
Arsenic	1.4
Barium	10.4 B
Beryllium	0.1 B
Chromium	2
Cobalt	0.57 B
Copper	1.9 B
Iron	1490
Lead	3.9
Manganese	91.5
Mercury	0.0051 B
Nickel	1.1 B
Silver	0.11 B
Vanadium	3.6 B
Zinc	40

Notes:

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N

0 100 200
Feet

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CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-3C
Human Health
Metal Sediment Distribution Map

FALCON REFINERY
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FIGURE
10C

G-42SD FR-198	
Aluminum	1080
Arsenic	0.43 B
Barium	23.1
Beryllium	0.055 B
Chromium	1.2
Cobalt	0.27 B
Copper	1.5 B
Iron	842
Lead	3.1
Manganese	16.4
Mercury	0.0019 B
Nickel	0.47 B
Vanadium	1.5 B
Zinc	26.7

G-43SD FR-199	
Aluminum	13400
Arsenic	6.3
Barium	176
Beryllium	0.52 B
Cadmium	0.25 B
Chromium	13.6
Cobalt	3.1 B
Copper	19.3
Iron	9650
Lead	14.1
Manganese	483
Mercury	0.022 B
Nickel	9.4
Selenium	0.47 B
Silver	0.32 B
Vanadium	19.8
Zinc	463

G-44SD FR-200	
Aluminum	1790
Arsenic	1.7
Barium	48.4
Beryllium	0.1 B
Chromium	2.4
Cobalt	0.67 B
Copper	2.5 B
Iron	1810
Lead	2.1
Manganese	47.7
Nickel	1.7 B
Vanadium	3.6 B
Zinc	88.2

G-51SD FR-193A	
Aluminum	2060
Arsenic	0.625 B
Barium	88.95
Beryllium	0.0965 B
Chromium	2.35
Cobalt	0.42 B
Copper	3.3
Iron	1480
Lead	4.9
Manganese	34.65
Mercury	0.015 B
Nickel	1.3 B
Vanadium	2.65 B
Zinc	92.5

G-52SD FR-195	
Aluminum	1900
Arsenic	0.75 B
Barium	47.8
Beryllium	0.098 B
Chromium	2.3
Cobalt	0.56 B
Copper	1.9 B
Iron	1580
Lead	3.1
Manganese	61.6
Mercury	0.0051 B
Nickel	1.1 B
Vanadium	3.5 B
Zinc	95.9

G-53SD FR-196	
Aluminum	5000
Arsenic	1.5
Barium	66.2
Beryllium	0.21 B
Chromium	4.5
Cobalt	1.4 B
Copper	3.6
Iron	3440
Lead	5.4
Manganese	168
Mercury	0.018 B
Nickel	2.7 B
Vanadium	6.7
Zinc	104

G-54SD FR-213	
Aluminum	2870
Arsenic	2.8
Barium	67.1
Beryllium	0.15 B
Chromium	3.3
Cobalt	0.62 B
Copper	2.9
Iron	2460
Lead	4.7
Manganese	72.7
Mercury	0.029
Nickel	2.4 B
Vanadium	6.1
Zinc	128

G-55SD FR-215	
Aluminum	12300
Arsenic	4.8
Barium	62.5
Beryllium	0.49 B
Cadmium	0.2 B
Chromium	11.8
Hex Chrom	7.3
Cobalt	3.2 B
Copper	20.7
Iron	8200
Lead	13.5
Manganese	97.3
Mercury	0.027 B
Nickel	8.6
Silver	0.15 B
Vanadium	18.8
Zinc	569

G-56SD FR-216	
Aluminum	2750
Arsenic	1.4
Barium	78.5
Beryllium	0.14 B
Chromium	3.3
Cobalt	0.79 B
Copper	2.8
Iron	2270
Lead	8.1
Manganese	60
Mercury	0.0034 B
Nickel	2.1 B
Selenium	0.34 B
Vanadium	5.4
Zinc	86.4

J-44SD FR-201A	
Aluminum	1205
Arsenic	0.455 B
Barium	36.8
Beryllium	0.0061 B
Chromium	1.35
Cobalt	0.235
Copper	1.8 B
Iron	857
Lead	3.55
Manganese	20.15
Mercury	0.015 B
Nickel	0.515 B
Vanadium	1.65 B
Zinc	42.45

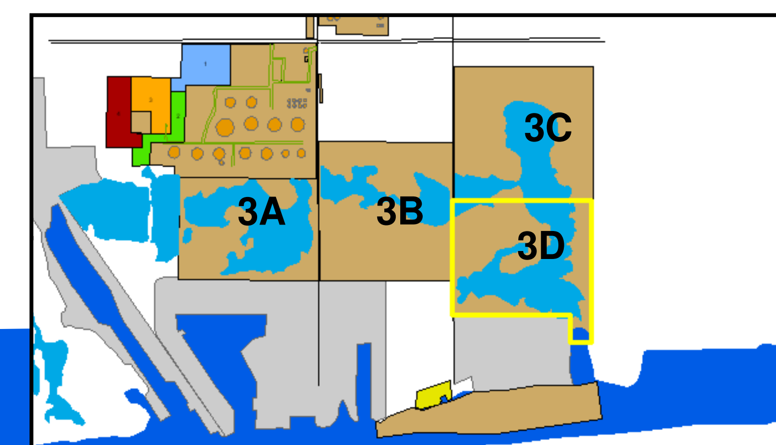
J-45SD FR-203	
Aluminum	1960
Arsenic	0.74 B
Barium	80.9
Beryllium	0.092 B
Chromium	2.4
Cobalt	0.56 B
Copper	2.1 B
Iron	1540
Lead	4.7
Manganese	58.9
Mercury	0.0061 B
Nickel	1.4 B
Silver	0.089 B
Vanadium	2.5 B
Zinc	91.4

J-57SD FR-212	
Aluminum	14500
Arsenic	6.5
Barium	134
Beryllium	0.58 B
Cadmium	0.33 B
Chromium	14.9
Hex Chrom	1.4 B
Cobalt	4.1 B
Copper	32.2
Iron	11000
Lead	17.9
Manganese	504
Mercury	0.031
Nickel	11.4
Selenium	0.39 B
Silver	0.24 B
Vanadium	20.7
Zinc	802

J-58SD FR-218	
Aluminum	2240
Arsenic	0.86 B
Barium	22.8 B
Beryllium	0.11 B
Chromium	2.5
Cobalt	0.67 B
Copper	3.5
Iron	2190
Lead	2.5
Manganese	65.1
Mercury	0.0047 B
Nickel	1.6 B
Selenium	0.31 B
Vanadium	3.8 B
Zinc	96

Legend

- Sediment Sample Points
- Soil Sample Points
- AOC-3D
- AOCs
- Industrial Zone
- Redfish Bay/IntraCoastal Waterway
- Wetland



Notes:

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N

0 100 200
Feet

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APPROVED BY:	

AOC-3D
Human Health
Metal Sediment Distribution Map

FALCON REFINERY
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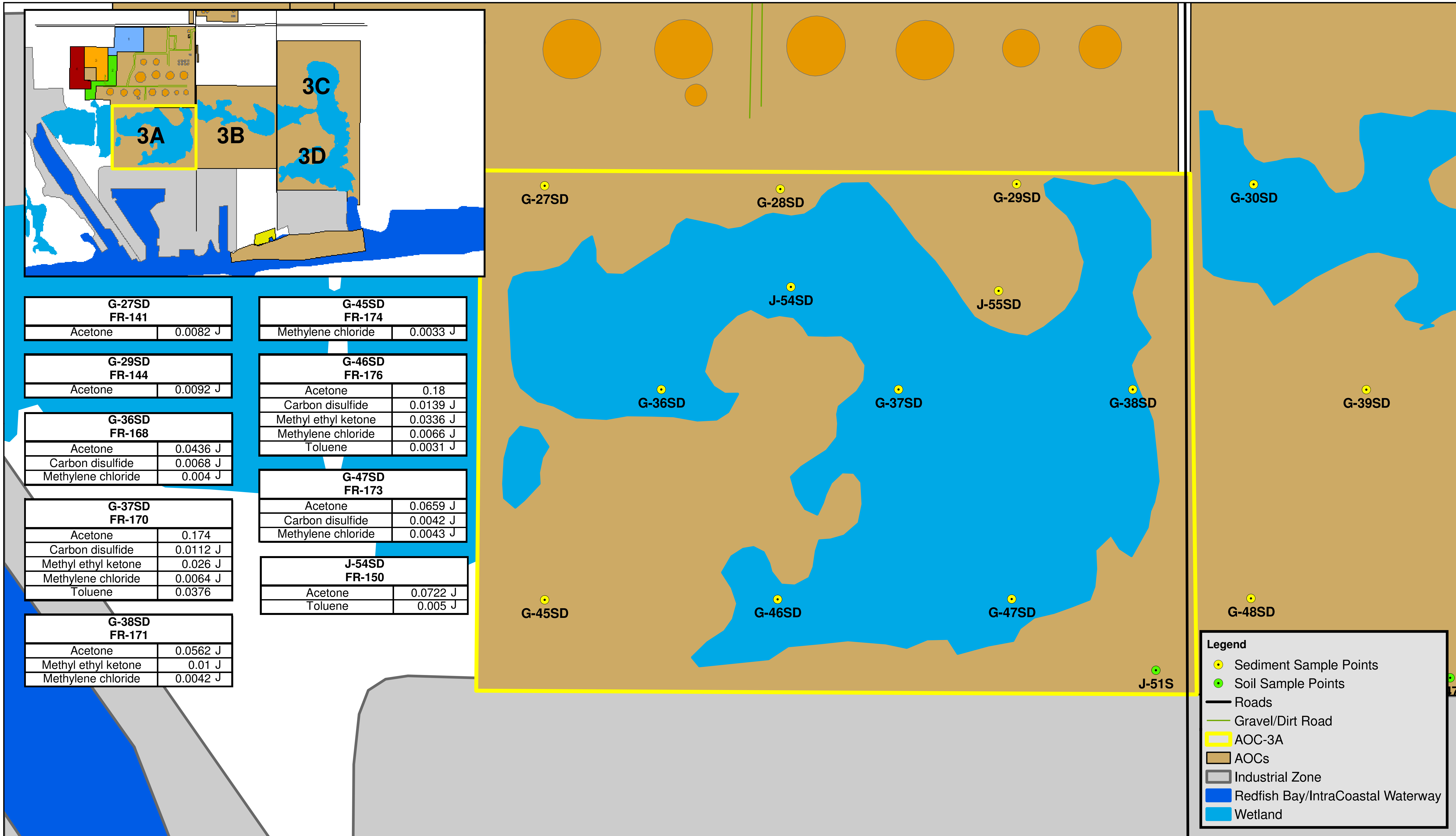
FIGURE
10D



G-27SD FR-141	
Acetone	0.0082 J

G-29SD FR-144	
Acetone	0.0092 J

G-36SD FR-168	
Acetone	0.0436 J
Carbon disulfide	0.0068 J
Methylene chloride	0.004 J

G-37SD FR-170	
Acetone	0.174
Carbon disulfide	0.0112 J
Methyl ethyl ketone	0.026 J
Methylene chloride	0.0064 J
Toluene	0.0376

G-38SD FR-171	
Acetone	0.0562 J
Methyl ethyl ketone	0.01 J
Methylene chloride	0.0042 J

G-45SD FR-174	
Methylene chloride	0.0033 J

G-46SD FR-176	
Acetone	0.18
Carbon disulfide	0.0139 J
Methyl ethyl ketone	0.0336 J
Methylene chloride	0.0066 J
Toluene	0.0031 J

G-47SD FR-173	
Acetone	0.0659 J
Carbon disulfide	0.0042 J
Methylene chloride	0.0043 J

J-54SD FR-150	
Acetone	0.0722 J
Toluene	0.005 J

Notes:

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N

0 150 300

Feet

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AOC-3A
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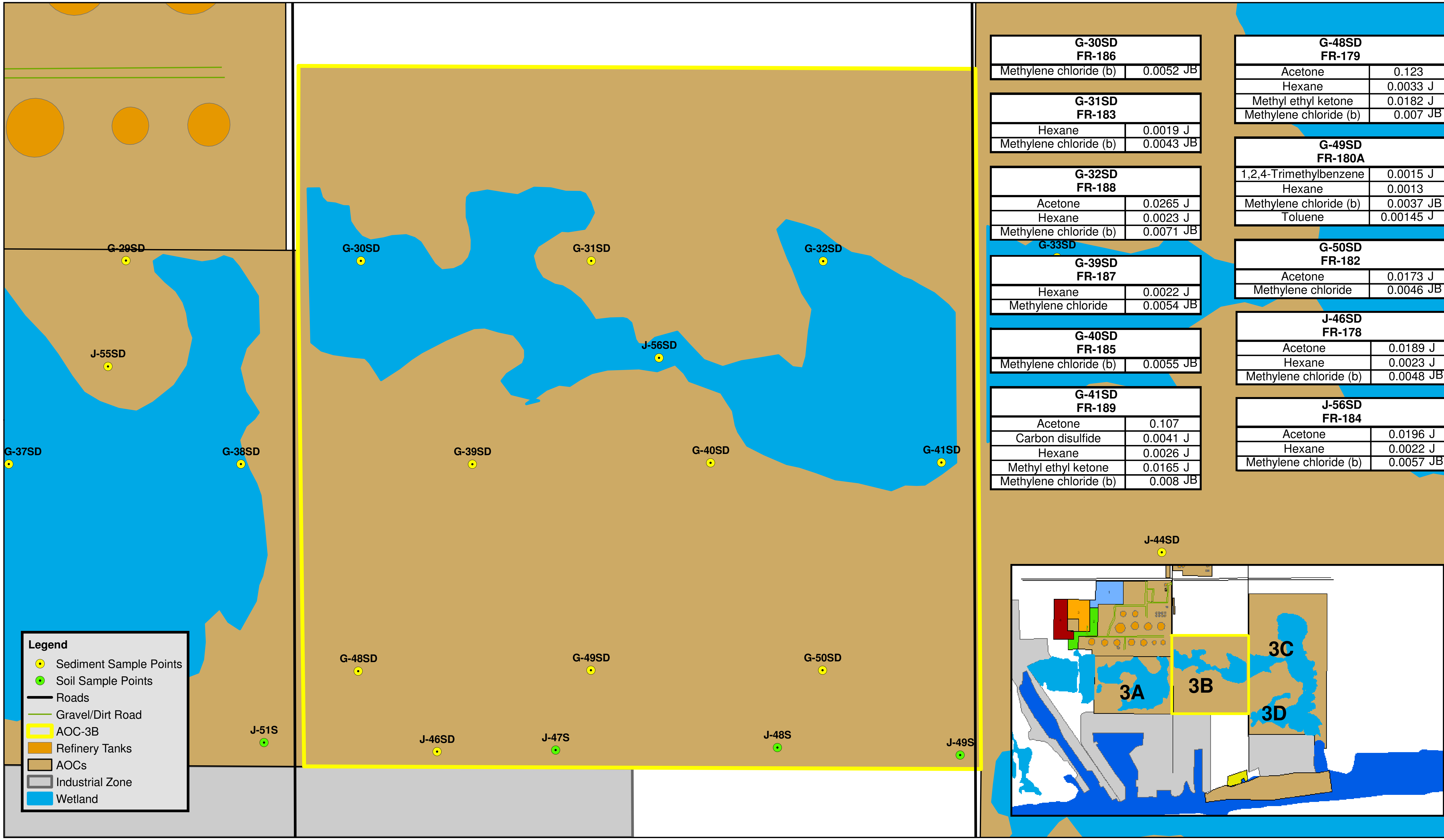
FIGURE
10E



G-30SD FR-186	
Methylene chloride (b)	0.0052 JB

G-31SD FR-183	
Hexane	0.0019 J
Methylene chloride (b)	0.0043 JB

G-32SD FR-188	
Acetone	0.0265 J
Hexane	0.0023 J
Methylene chloride (b)	0.0071 JB

G-39SD FR-187	
Hexane	0.0022 J
Methylene chloride	0.0054 JB

G-40SD FR-185	
Methylene chloride (b)	0.0055 JB

G-41SD FR-189	
Acetone	0.107
Carbon disulfide	0.0041 J
Hexane	0.0026 J
Methyl ethyl ketone	0.0165 J
Methylene chloride (b)	0.008 JB

G-48SD FR-179	
Acetone	0.123
Hexane	0.0033 J
Methyl ethyl ketone	0.0182 J
Methylene chloride (b)	0.007 JB

G-49SD FR-180A	
1,2,4-Trimethylbenzene	0.0015 J
Hexane	0.0013
Methylene chloride (b)	0.0037 JB
Toluene	0.00145 J

G-50SD FR-182	
Acetone	0.0173 J
Methylene chloride	0.0046 JB

J-46SD FR-178	
Acetone	0.0189 J
Hexane	0.0023 J
Methylene chloride (b)	0.0048 JB

J-56SD FR-184	
Acetone	0.0196 J
Hexane	0.0022 J
Methylene chloride (b)	0.0057 JB

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

B = Analyte found in associated method blank

N

0 100 200

Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-3B
Human Health
VOC Sediment Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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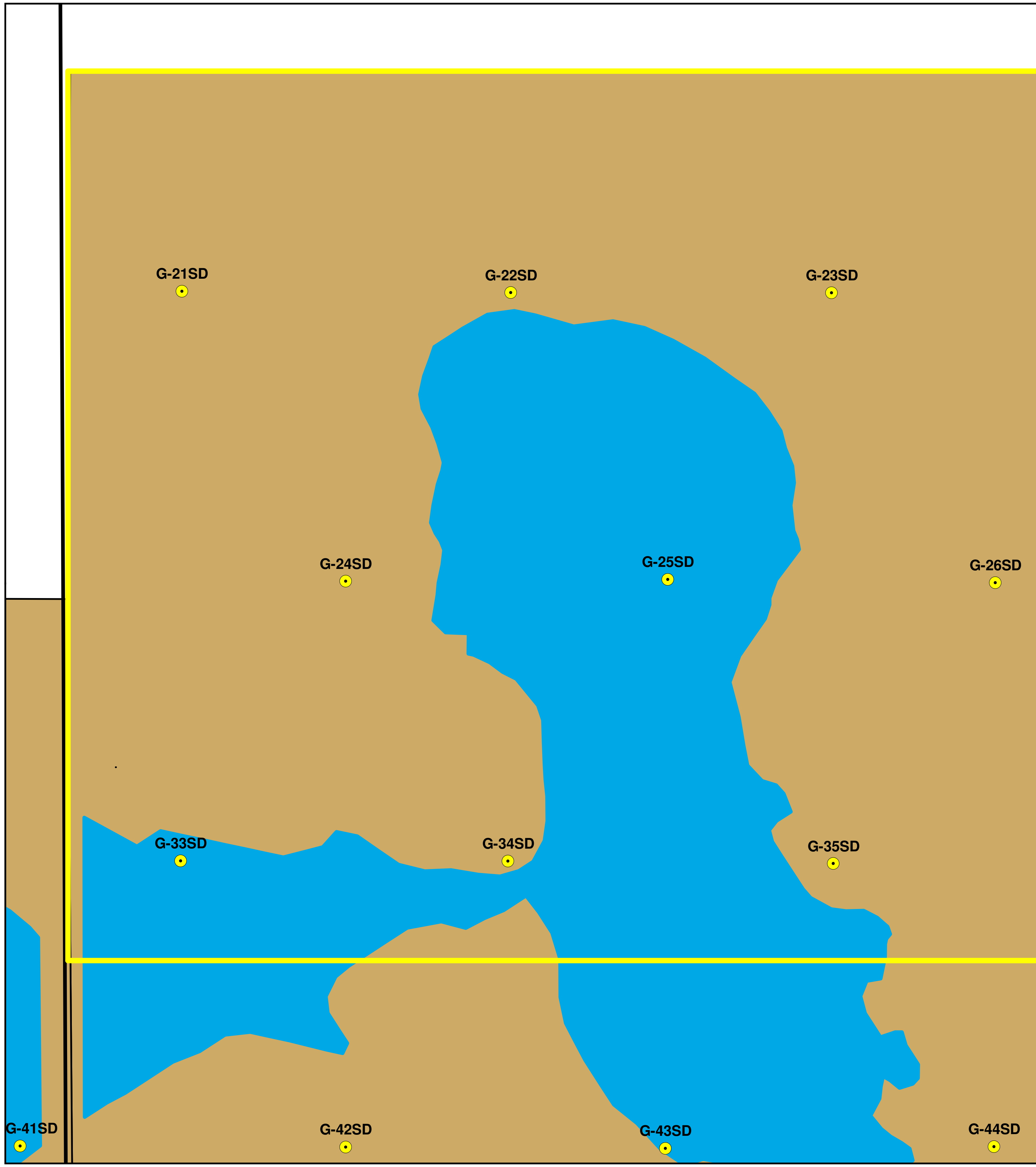
FIGURE
10F



G-21SD FR-210	
Acetone	0.048 J
Methylene chloride (b)	0.0038 JB

G-22SD FR-209	
Acetone	0.668
Carbon disulfide	0.0241 J
Hexane	0.0086 J
Methyl ethyl ketone	0.135 J
Methylene chloride (b)	0.0199 JB

G-23SD FR-208	
Methylene chloride (b)	0.0079 JB

G-24SD FR-204	
Methylene chloride	0.0058 J

G-25SD FR-205	
Acetone	0.0135 J
Methylene chloride	0.0037 J

G-26SD FR-206A	
Methylene chloride	0.0057 J

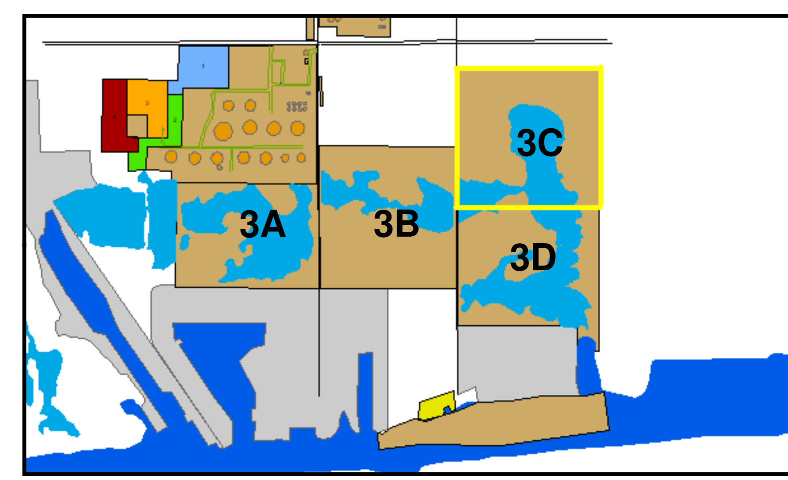
G-33SD FR-190	
Acetone	0.151
Carbon disulfide	0.0029 J
Hexane	0.0026 J
Methyl ethyl ketone	0.029 J
Methylene chloride (b)	0.0063 JB

G-34SD FR-191	
Methylene chloride (b)	0.0059 JB

G-35SD FR-192	
Methylene chloride (b)	0.0064 JB

Legend

- Sediment Sample Points
- Roads
- AOC-3C
- Refinery Tanks
- AOCs
- Wetland



Notes:

1. Results are posted in mg/kg
2. Qualifiers:
   J = Concentration greater than the SDL but less than the method quantitation limit (MQL)
   B = Analyte found in associated method blank

N

0 150 300
Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-3C
Human Health
VOC Sediment Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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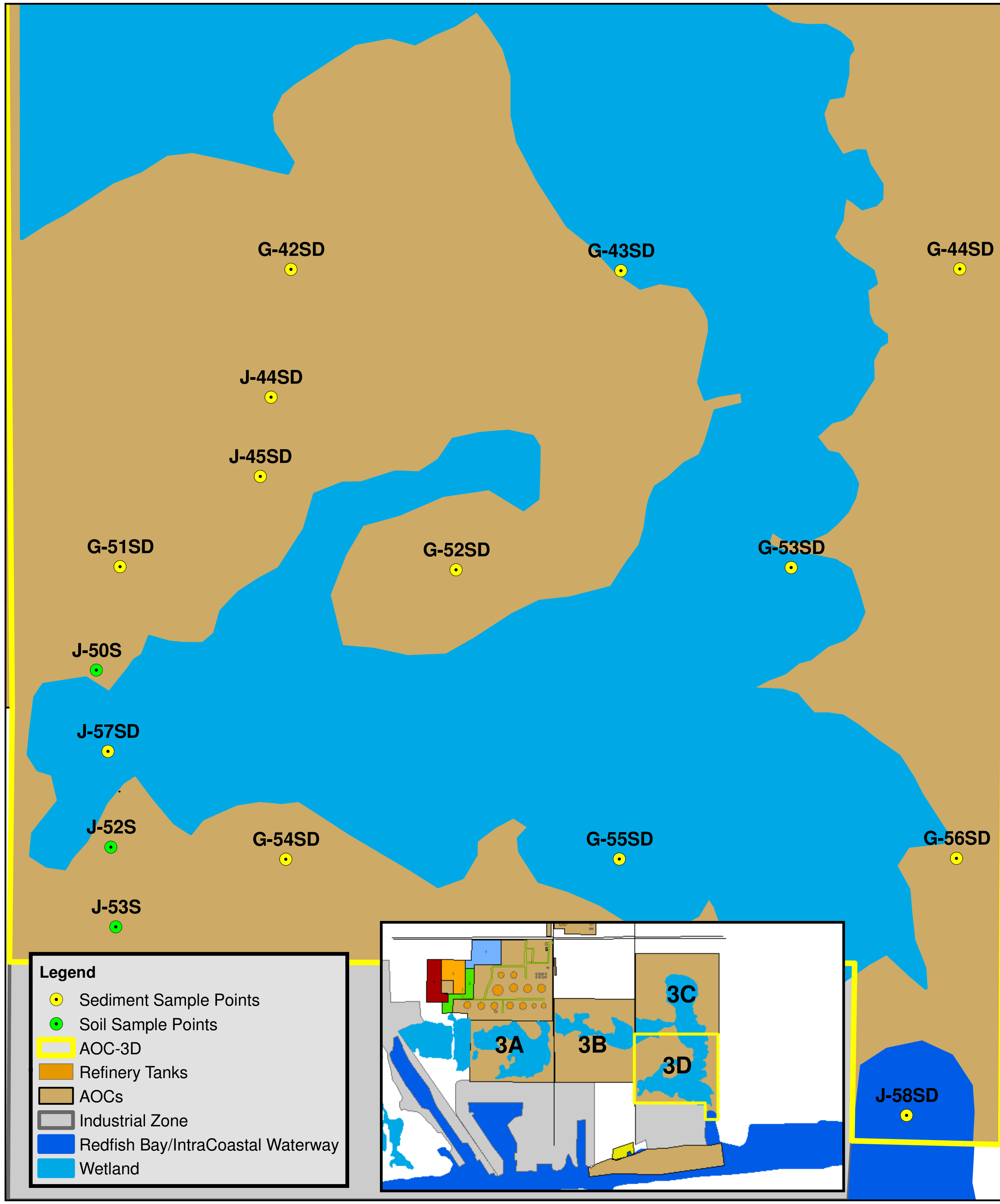
FIGURE
10G



G-42SD FR-198	
1,2,4-Trimethylbenzene	0.0014 J
Acetone	0.0336 J

G-43SD FR-199	
Acetone	0.0698 J
Hexane	0.0063 J
Methyl ethyl ketone	0.0154 J
Methylene chloride	0.0043 J

G-44SD FR-200	
1,2,4-Trimethylbenzene	0.0045 J
Ethylbenzene	0.0015 J
Methylene chloride	0.0048 J
Toluene	0.0027 J
Xylene (total)	0.0061 J

G-51SD FR-193A	
1,2,4-Trimethylbenzene	0.0049
Acetone	0.0492
Benzene	0.0016 J
Ethylbenzene	0.00305 J
Isopropylbenzene	0.0015 J
Methylene chloride	0.0057 J
n-Propylbenzene	0.0024 J
Toluene	0.00415
Xylene (total)	0.0099 J

G-52SD FR-196	
Methylene chloride	0.005 JB

G-53SD FR-196	
Acetone	0.0111 J
Methylene chloride (b)	0.0058 JB

G-54SD FR-213	
1,2,4-Trimethylbenzene	0.0018 J
Methylene chloride	0.0055 J
Toluene	0.0022 J

G-55SD FR-215	
Acetone	0.128
Carbon disulfide	0.009 J
Methyl ethyl ketone	0.0255 J
Methylene chloride (b)	0.0069 JB

G-56SD FR-216	
Methylene chloride (b)	0.0042 JB

J-44SD FR-201A	
Acetone	0.088
Methylene chloride	0.00295

J-45SD FR-203	
Acetone	0.0112 J
Methylene chloride	0.0047 J

J-57SD FR-212	
Acetone	0.15
Carbon disulfide	0.0048 J
Methyl ethyl ketone	0.0264 J
Methylene chloride (b)	0.0057 JB

J-58SD FR-218	
Acetone	0.0499 J
Carbon disulfide	0.0032 J
Methyl ethyl ketone (b)	0.0119 JB
Methylene chloride	0.0036 J

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

B = Analyte found in associated method blank

N

0 150 300
Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-3D
Human Health
VOC Sediment Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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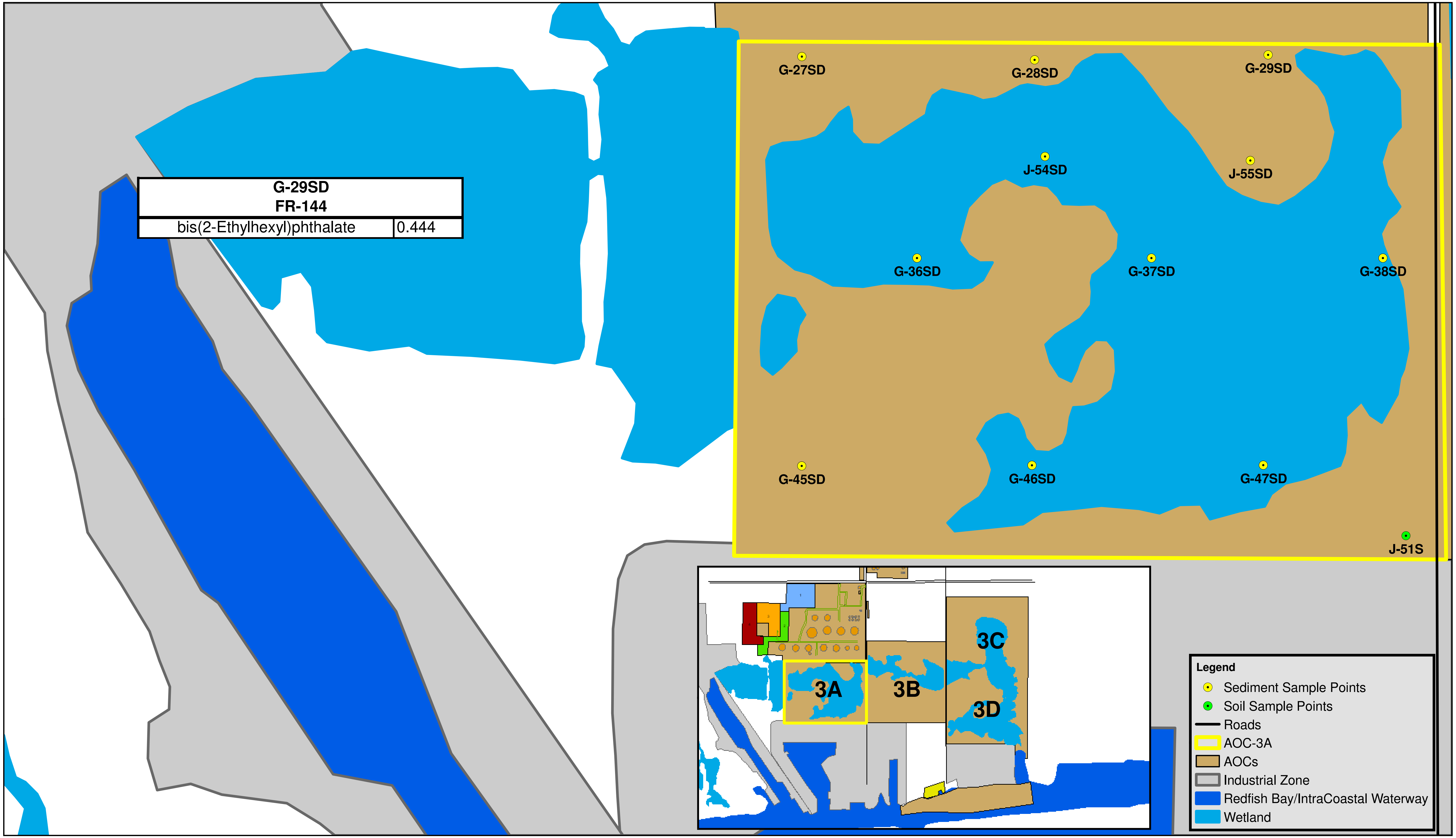
FIGURE
10H



Notes:

1. Results are posted in mg/kg

N

0 150 300

Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09	**AOC-3A Human Health SVOC Sediment Distribution Map**
DRAFTED BY:	C. SEATON	FALCON REFINERY
CHECKED BY:	S. HALASZ	INGLESIDE, SAN PATRICIO COUNTY, TEXAS
APPROVED BY:		PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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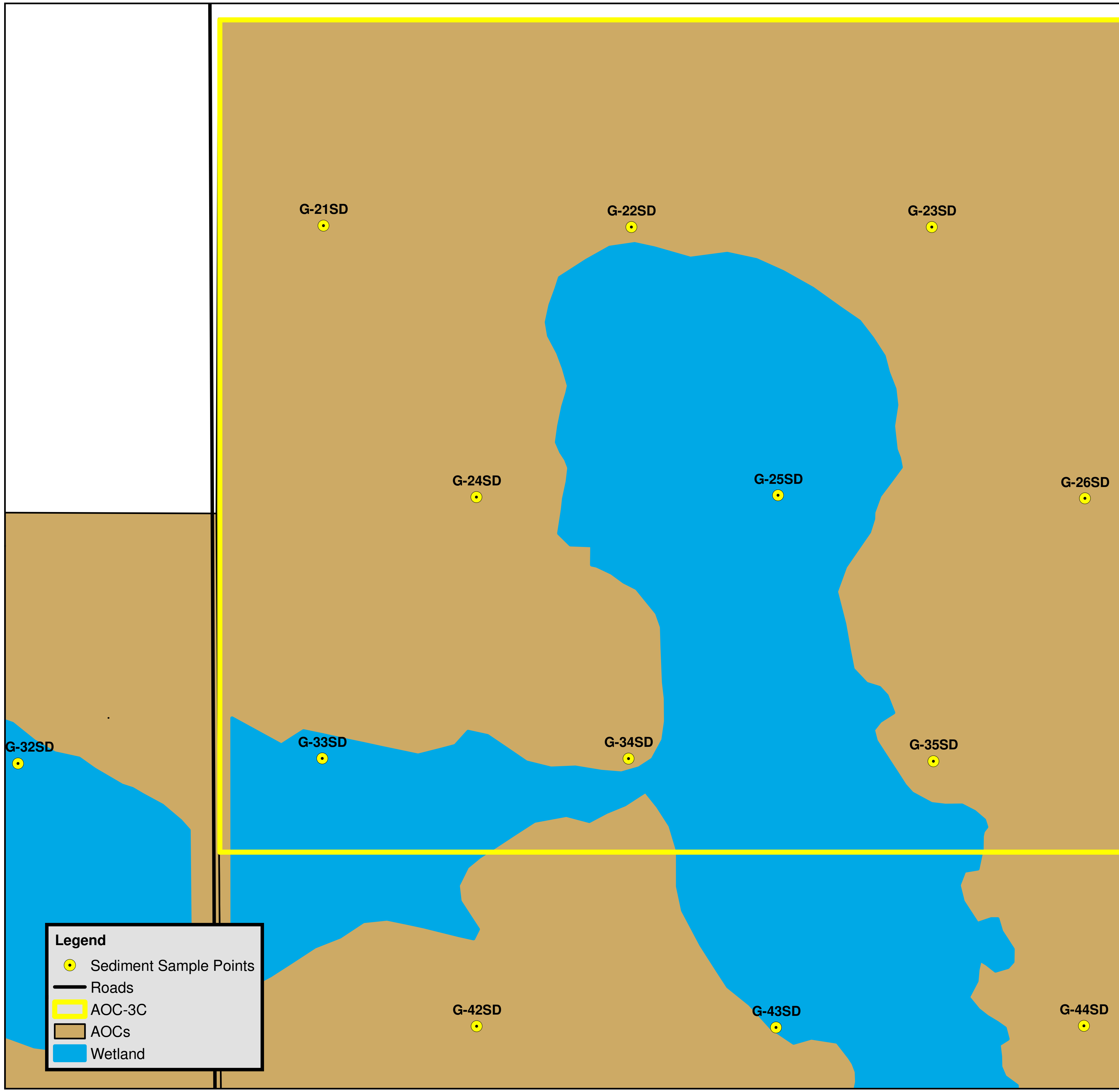
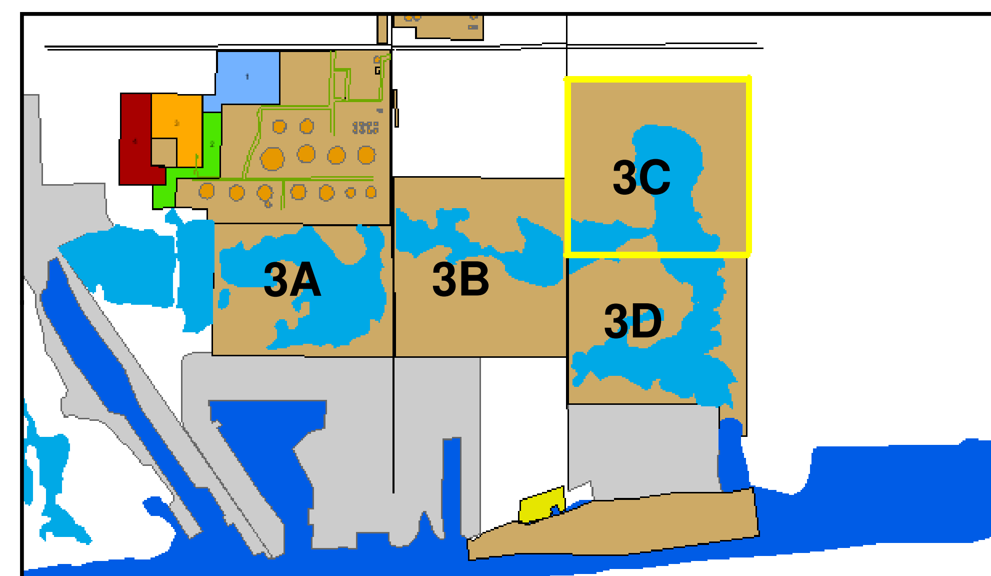
FIGURE

10I



G-21SD	
FR-210	
bis(2-Ethylhexyl)phthalate	0.153 J



Notes:

1. Results are posted in mg/kg
2. Qualifiers:

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

N

0 100 200

Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
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CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-3C
Human Health
SVOC Sediment Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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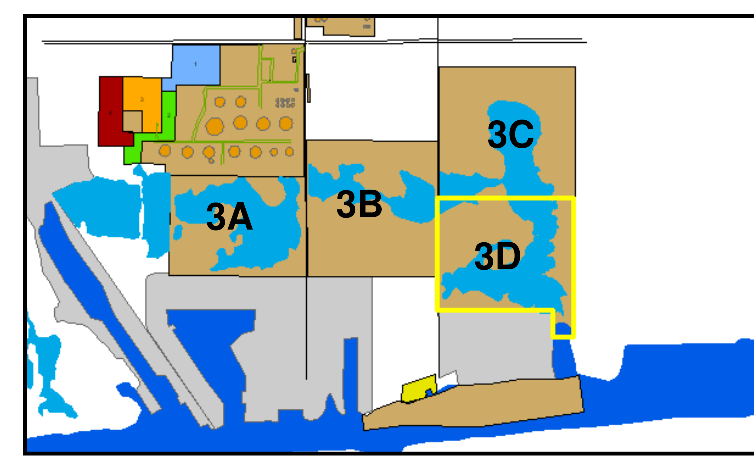
FIGURE
10J

G-51SD FR-193A	
bis(2-Ethylhexyl)phthalate	0.136

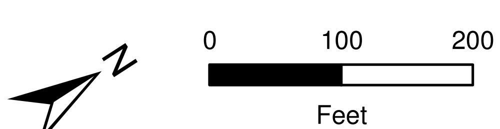
Legend

- Sediment Sample Points
- Soil Sample Points
- AOC-3D
- AOCs
- Industrial Zone
- Redfish Bay/IntraCoastal Waterway
- Wetland



Notes:

1. Results are posted in mg/kg



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DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-3D Human Health SVOC Sediment Distribution Map

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INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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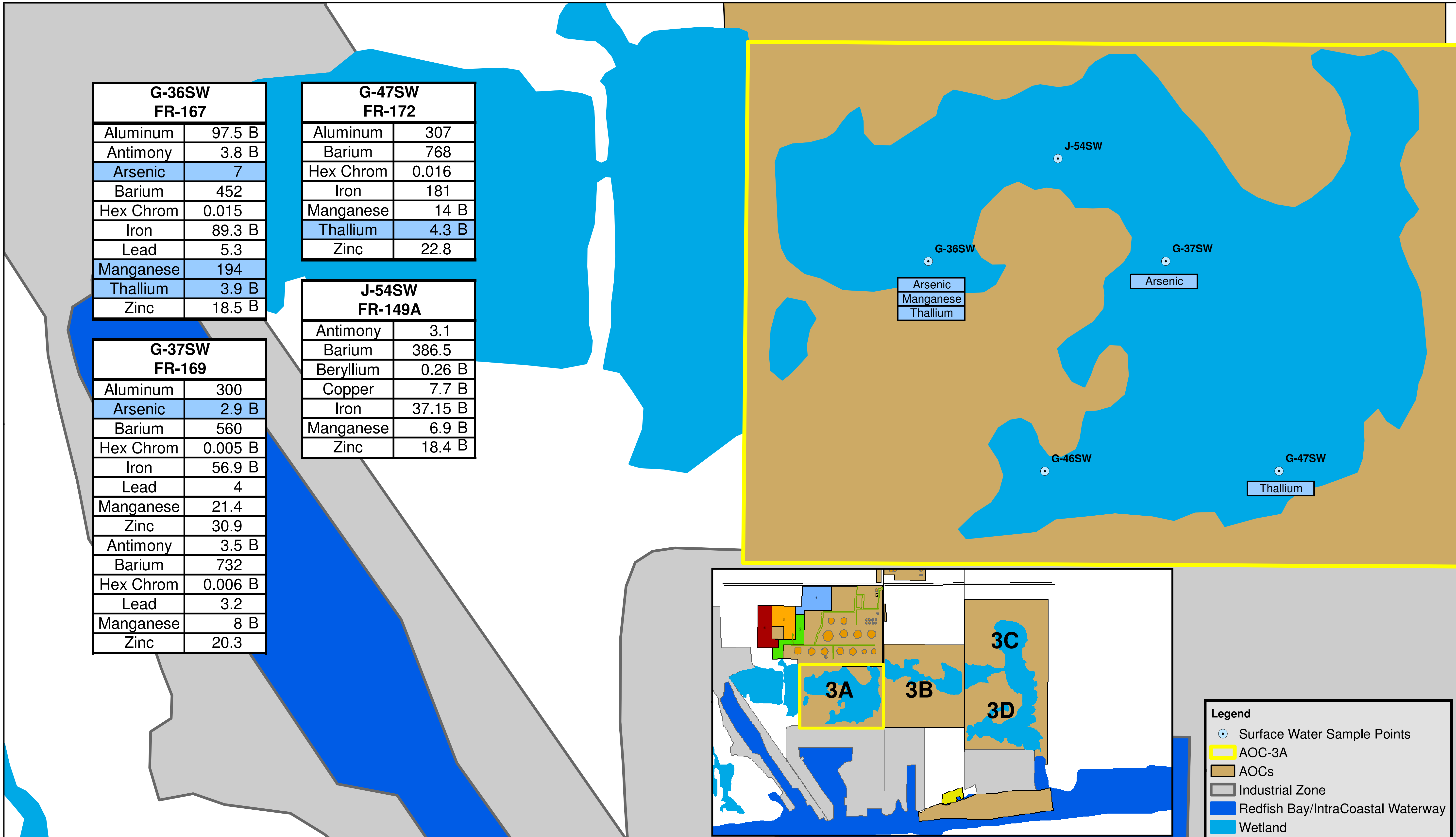
FIGURE
10K



G-36SW FR-167	
Aluminum	97.5 B
Antimony	3.8 B
Arsenic	7
Barium	452
Hex Chrom	0.015
Iron	89.3 B
Lead	5.3
Manganese	194
Thallium	3.9 B
Zinc	18.5 B

G-47SW FR-172	
Aluminum	307
Barium	768
Hex Chrom	0.016
Iron	181
Manganese	14 B
Thallium	4.3 B
Zinc	22.8

J-54SW FR-149A	
Antimony	3.1
Barium	386.5
Beryllium	0.26 B
Copper	7.7 B
Iron	37.15 B
Manganese	6.9 B
Zinc	18.4 B

G-37SW FR-169	
Aluminum	300
Arsenic	2.9 B
Barium	560
Hex Chrom	0.005 B
Iron	56.9 B
Lead	4
Manganese	21.4
Zinc	30.9
Antimony	3.5 B
Barium	732
Hex Chrom	0.006 B
Lead	3.2
Manganese	8 B
Zinc	20.3

Notes:

1. Results are posted in µg/l
Hex Chrom posted in mg/l

2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds [SW]RBELs

N

0 100 200

Feet

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APPROVED BY:	

AOC-3A
Human Health
Metal Surface Water Distribution Map

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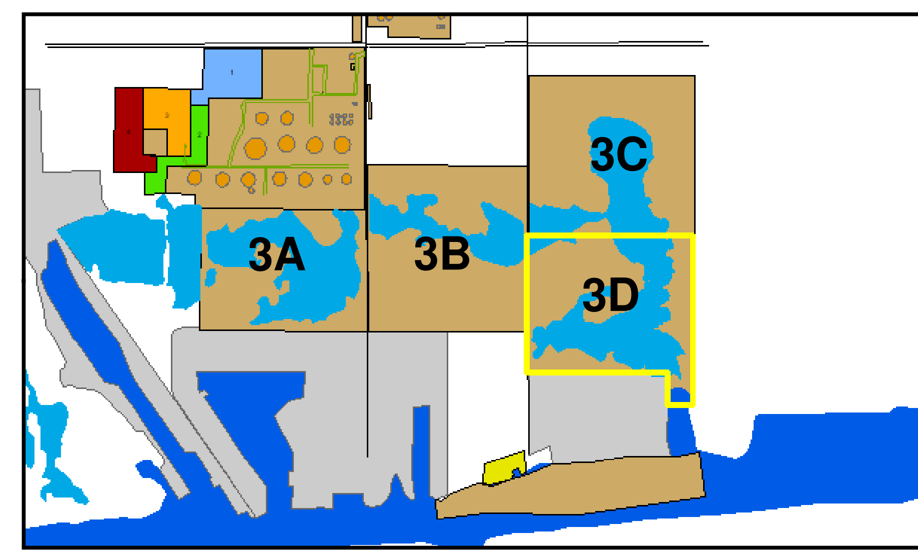
FIGURE
11A

J-57SW FR-211	
Aluminum	699
Antimony	4.1 B
Arsenic	10.6
Barium	393
Iron	576
Lead	4.8
Manganese	151
Nickel	3.7 B
Vanadium	5.1 B
Zinc	75.8

J-58SW FR-217	
Aluminum	128 B
Antimony	4.2 B
Barium	49.1 B
Iron	104
Lead	10.2
Manganese	14.5 B
Thallium	9.2 B
Vanadium	1.6 B
Zinc	21.7

Legend
- Surface Water Sample Points
- AOC-3D
- AOCs
- Industrial Zone
- Redfish Bay/IntraCoastal Waterway
- Wetland



Notes:

1. Results are posted in µg/l
2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds ^{SW}RBELs

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
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AOC-3D
Human Health
Metal Surface Water Soil Distribution Map

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INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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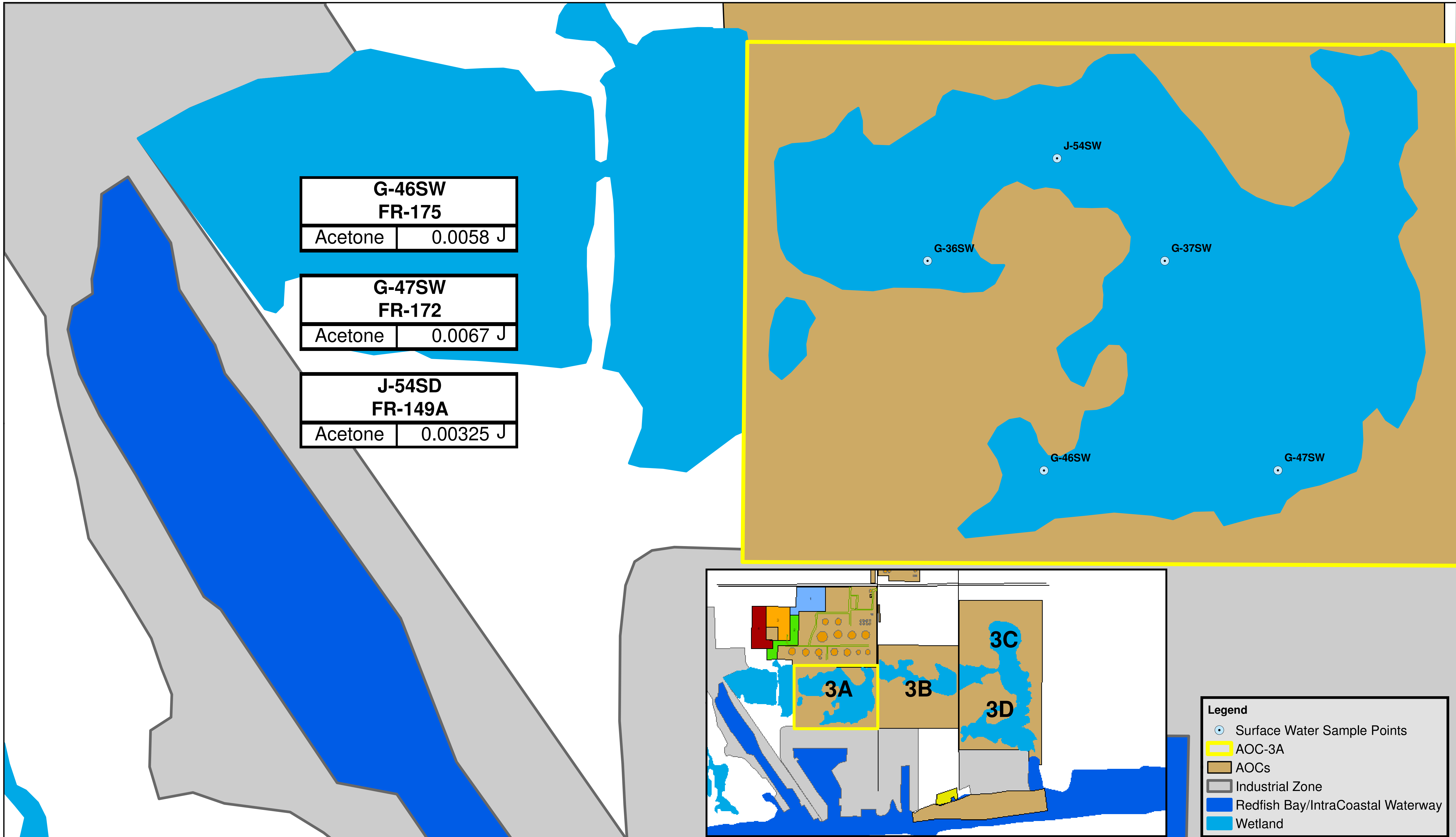
FIGURE
11B



Notes:

1. Results are posted in mg/l

2. Qualifiers:

J = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
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CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-3A
Human Health
VOC Surface Water Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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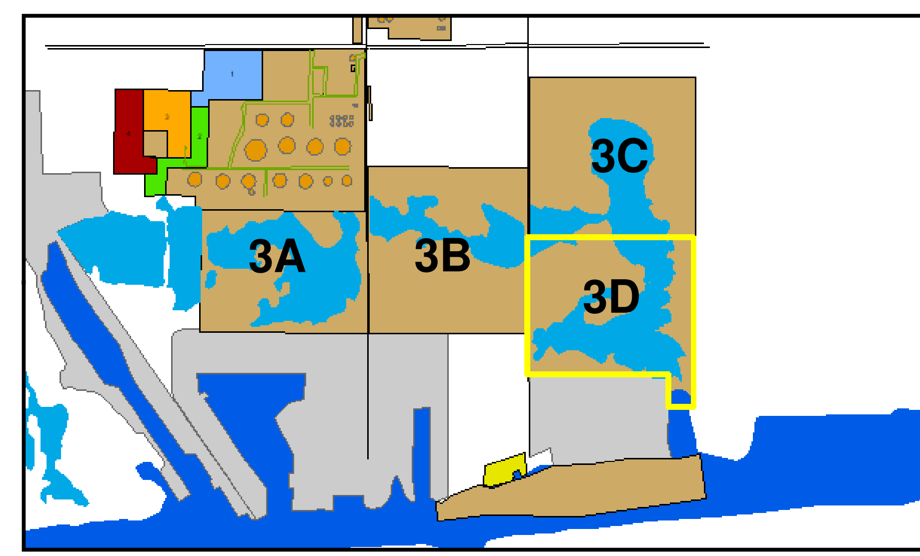
FIGURE
11C

J-57SW FR-211	
Acetone	0.0056 J



Notes:

1. Results are posted in mg/l

2. Qualifiers:

J = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

0 100 200
Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
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APPROVED BY:	

AOC-3D
Human Health
VOC Surface Water Soil Distribution Map

FALCON REFINERY
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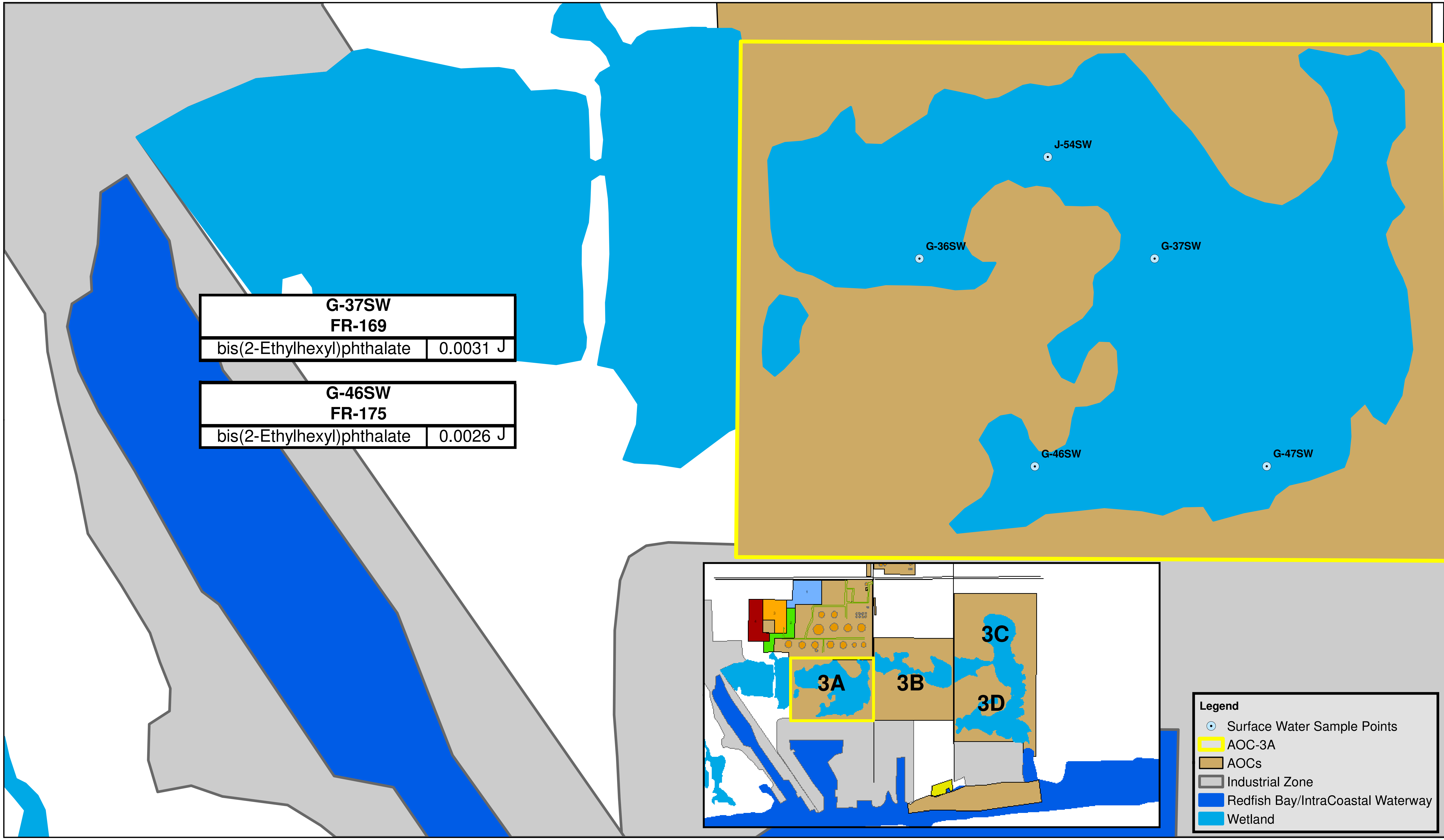
FIGURE
11D



Notes:

1. Results are posted in mg/l

2. Qualifiers:

J = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

N

0 100 200

Feet

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APPROVED BY:	

AOC-3A
Human Health
SVOC Surface Water Distribution Map

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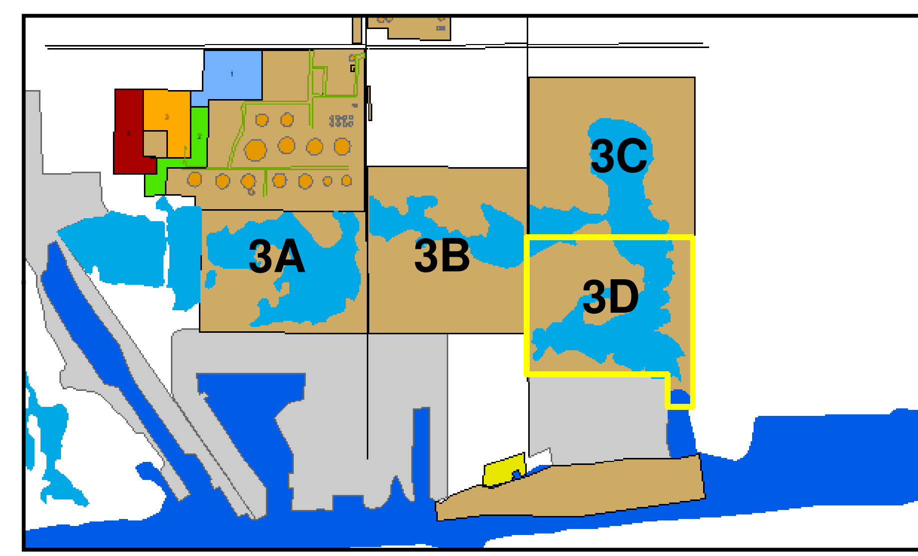
FIGURE
11E

J-57SW FR-211	
bis(2-Ethylhexyl)phthalate	0.0026 J



Notes:

1. Results are posted in mg/l

2. Qualifiers:

J = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

N

0 100 200

Feet

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CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-3D
Human Health
SVOC Surface Water Soil Distribution Map

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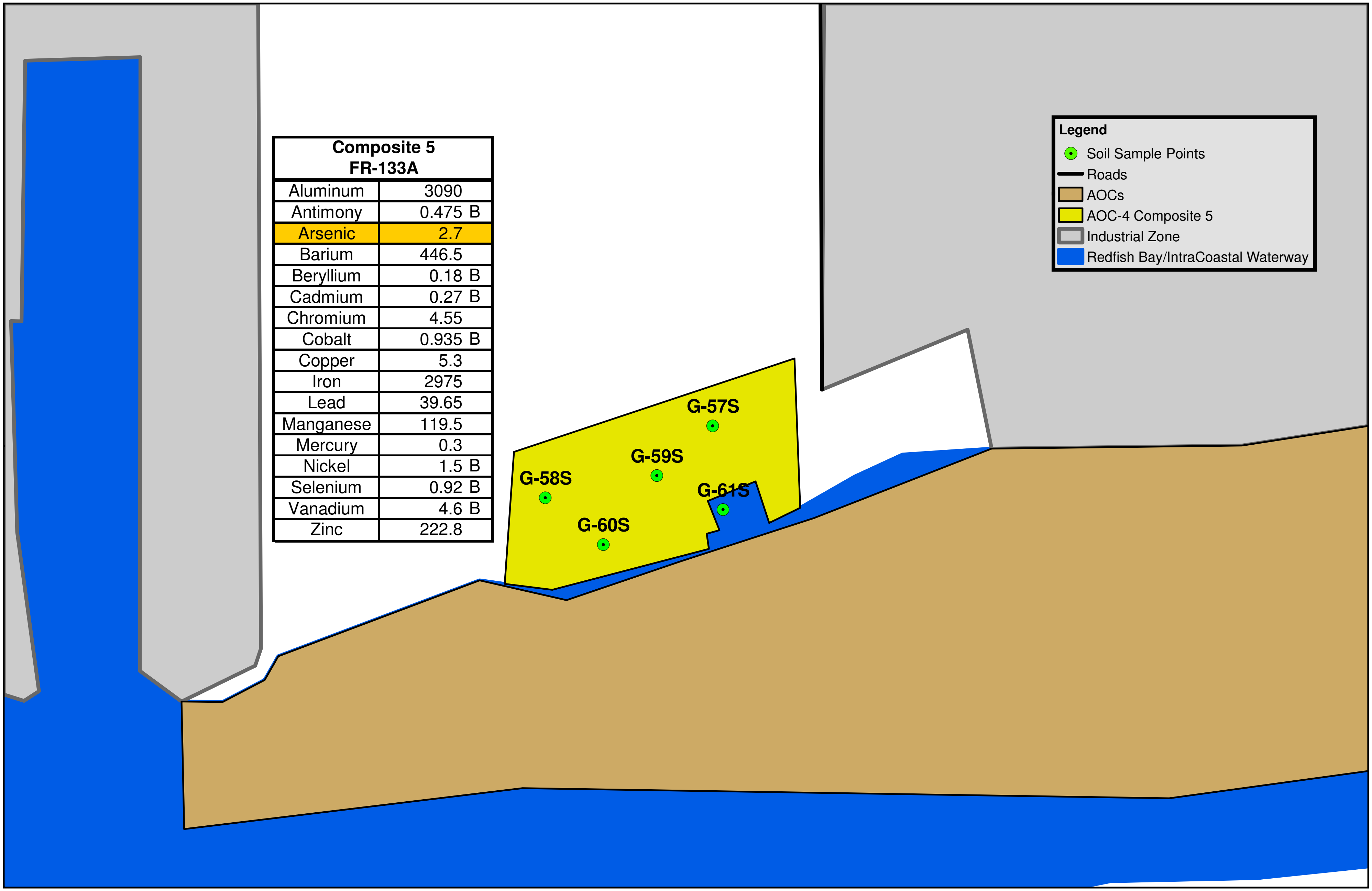
FIGURE

11F



Composite 5 FR-133A	
Aluminum	3090
Antimony	0.475 B
Arsenic	2.7
Barium	446.5
Beryllium	0.18 B
Cadmium	0.27 B
Chromium	4.55
Cobalt	0.935 B
Copper	5.3
Iron	2975
Lead	39.65
Manganese	119.5
Mercury	0.3
Nickel	1.5 B
Selenium	0.92 B
Vanadium	4.6 B
Zinc	222.8

Notes:

1. Results are posted in mg/kg

2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

N

Above EPA MSSL

0 100 200

Feet

DATE DRAWN: 5/7/08	DATE REVISED: 4/1/09
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CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-4
Human Health
Metal Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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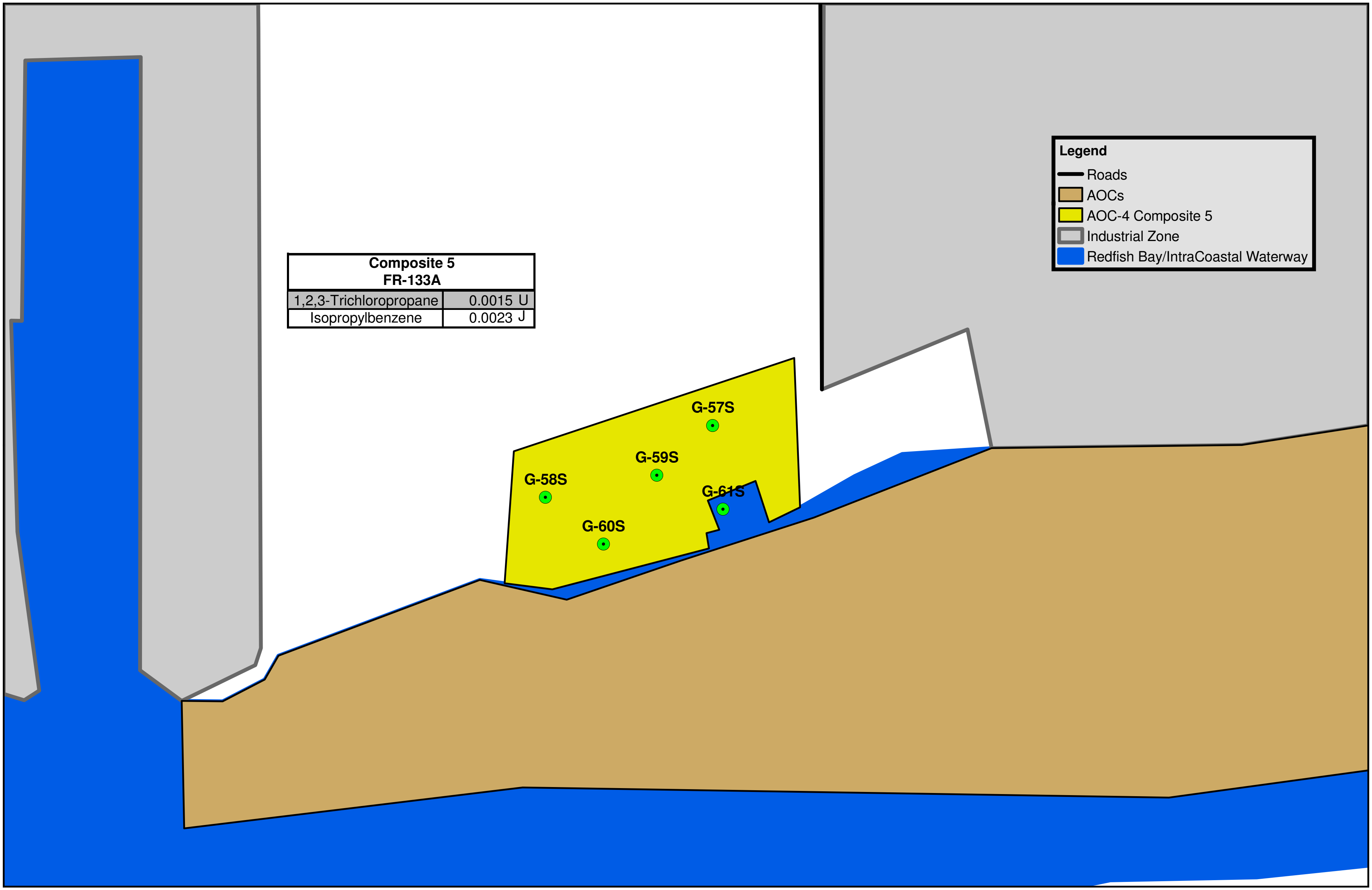
FIGURE
12A



Notes:

1. Results are posted in mg/kg
2. Qualifiers:
   U = Undetected at the sample detection limit (SDL)
   J = Concentration greater than the sample detection limit (SDL) but less than the method

SDL Exceeds TCEQ Screening Level

N

0 80 160
Feet

DATE DRAWN: 5/7/08	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-4
Human Health
VOC Surface Soil Distribution Map

FALCON REFINERY
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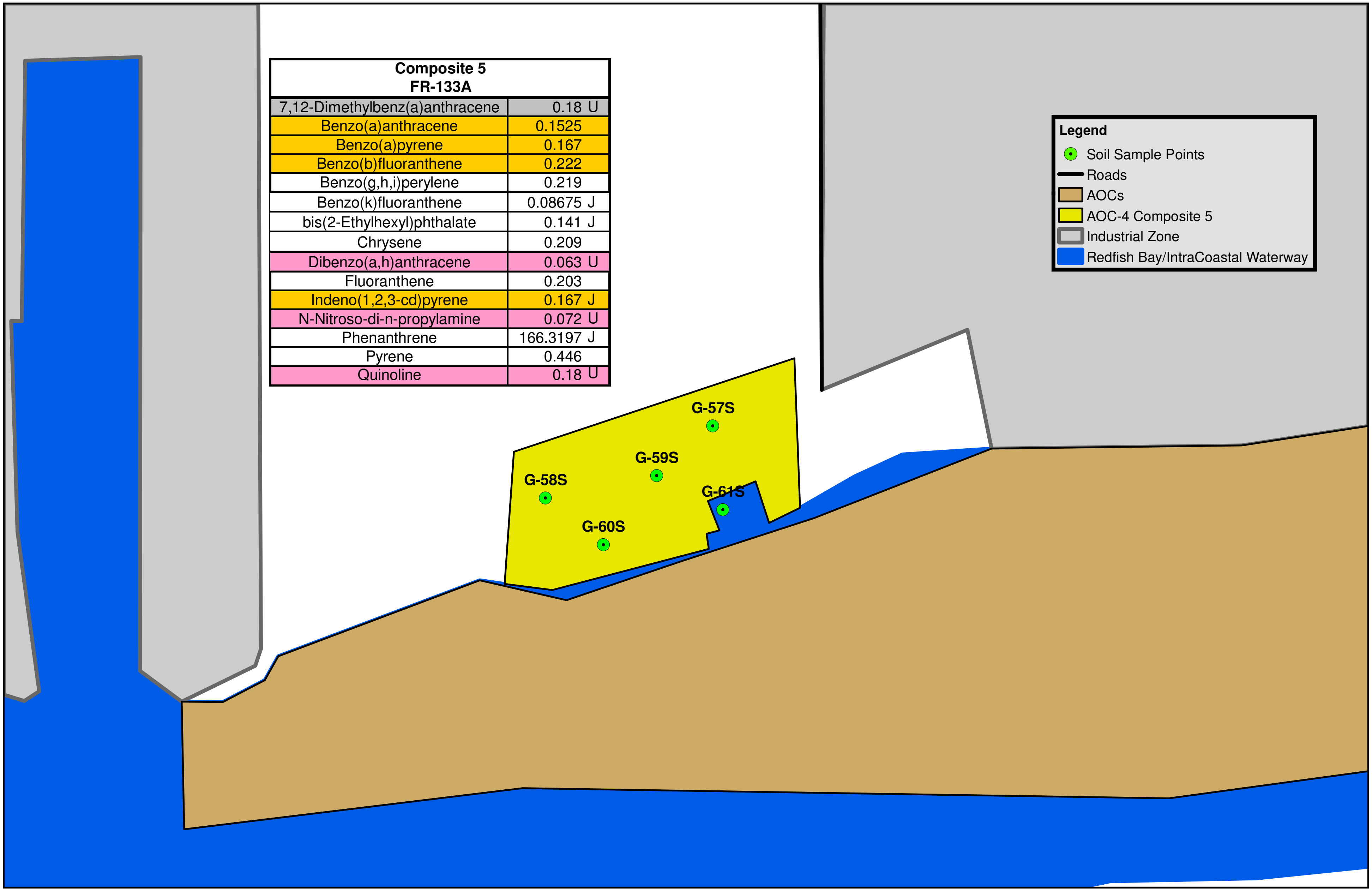
FIGURE
12B



Composite 5 FR-133A	
7,12-Dimethylbenz(a)anthracene	0.18 U
Benzo(a)anthracene	0.1525
Benzo(a)pyrene	0.167
Benzo(b)fluoranthene	0.222
Benzo(g,h,i)perylene	0.219
Benzo(k)fluoranthene	0.08675 J
bis(2-Ethylhexyl)phthalate	0.141 J
Chrysene	0.209
Dibenzo(a,h)anthracene	0.063 U
Fluoranthene	0.203
Indeno(1,2,3-cd)pyrene	0.167 J
N-Nitroso-di-n-propylamine	0.072 U
Phenanthrene	166.3197 J
Pyrene	0.446
Quinoline	0.18 U

Notes:

1. Results are posted in mg/kg
2. Qualifiers:
   U = Undetected at the sample detection limit (SDL)
   J = Concentration greater than the sample detection limit (SDL) but less than the method

Exceeds EPA Region 6 MSSL
SDL Exceeds EPA Screening Level
SDL Exceeds TCEQ Screening Level

0 100 200
Feet

N

DATE DRAWN:	DATE REVISED:
5/7/08	4/1/09
DRAFTED BY: C. SEATON	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-4
Human Health
SVOC Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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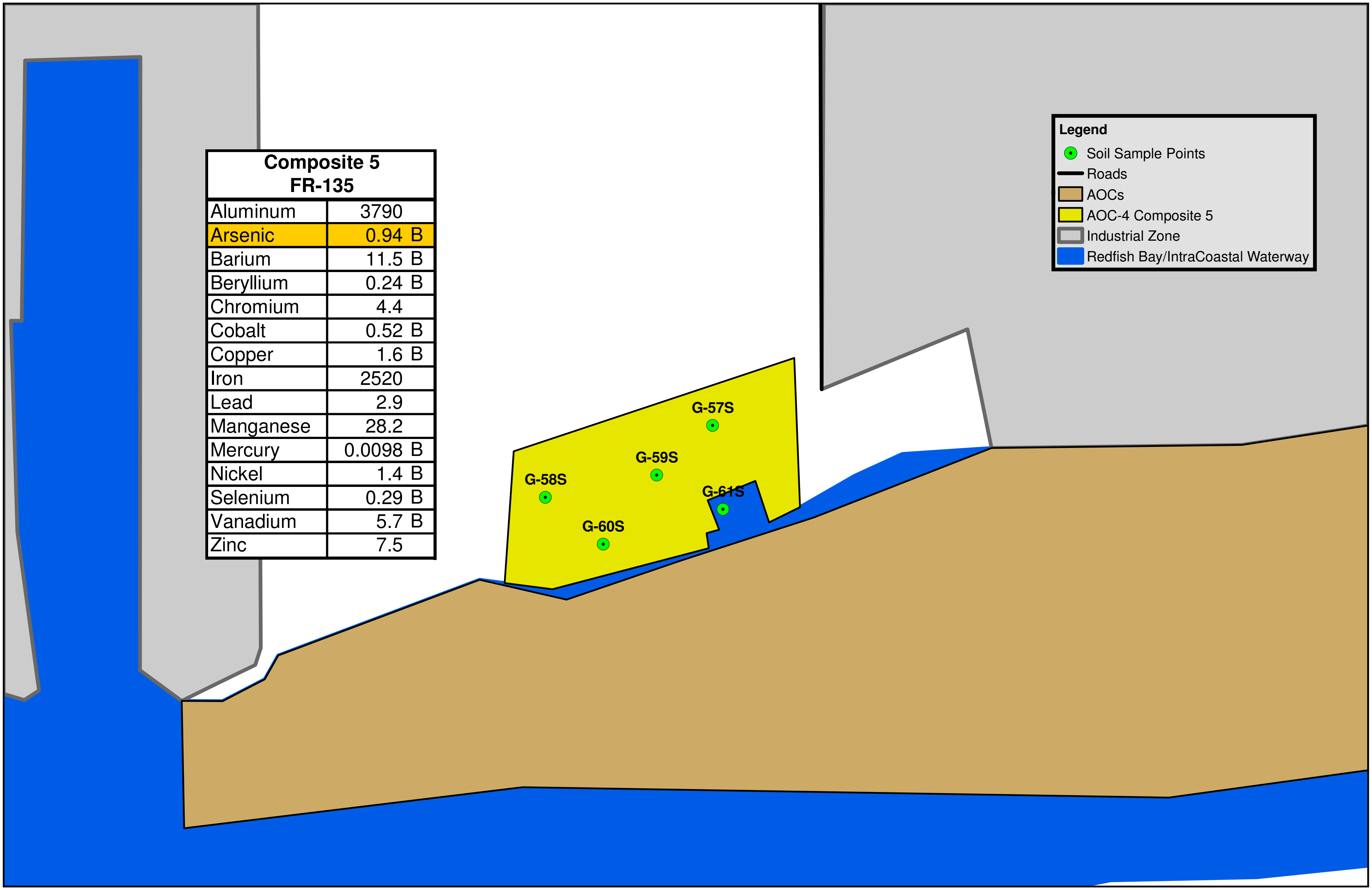
FIGURE
12C



Composite 5 FR-135	
Aluminum	3790
Arsenic	0.94 B
Barium	11.5 B
Beryllium	0.24 B
Chromium	4.4
Cobalt	0.52 B
Copper	1.6 B
Iron	2520
Lead	2.9
Manganese	28.2
Mercury	0.0098 B
Nickel	1.4 B
Selenium	0.29 B
Vanadium	5.7 B
Zinc	7.5

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Above EPA MSSL

N

0 100 200
Feet

DATE DRAWN: 5/7/08	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-4
Human Health
Metal Subsurface Soil Distribution Map

FALCON REFINERY
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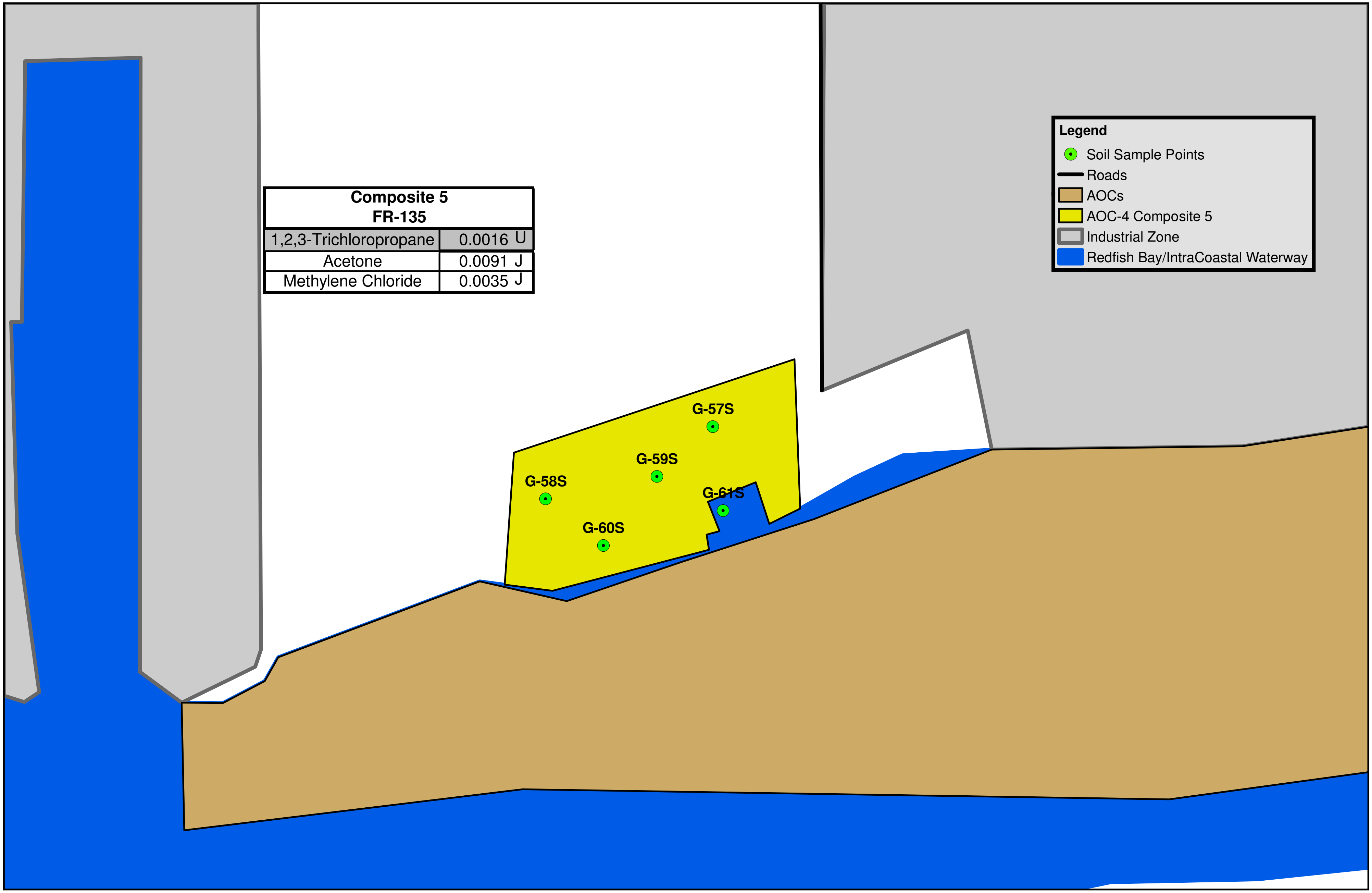
FIGURE
13A



Composite 5 FR-135	
1,2,3-Trichloropropane	0.0016 U
Acetone	0.0091 J
Methylene Chloride	0.0035 J

Notes:

1. Results are posted in mg/kg
2. Qualifiers:
   - U = Undetected at the sample detection limit (SDL)
   - J = Concentration greater than the sample detection limit (SDL) but less than the method

SDL Exceeds TCEQ Screening Level

N

0 90 180

Feet

DATE DRAWN: 5/7/08	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-4
Human Health
VOC Subsurface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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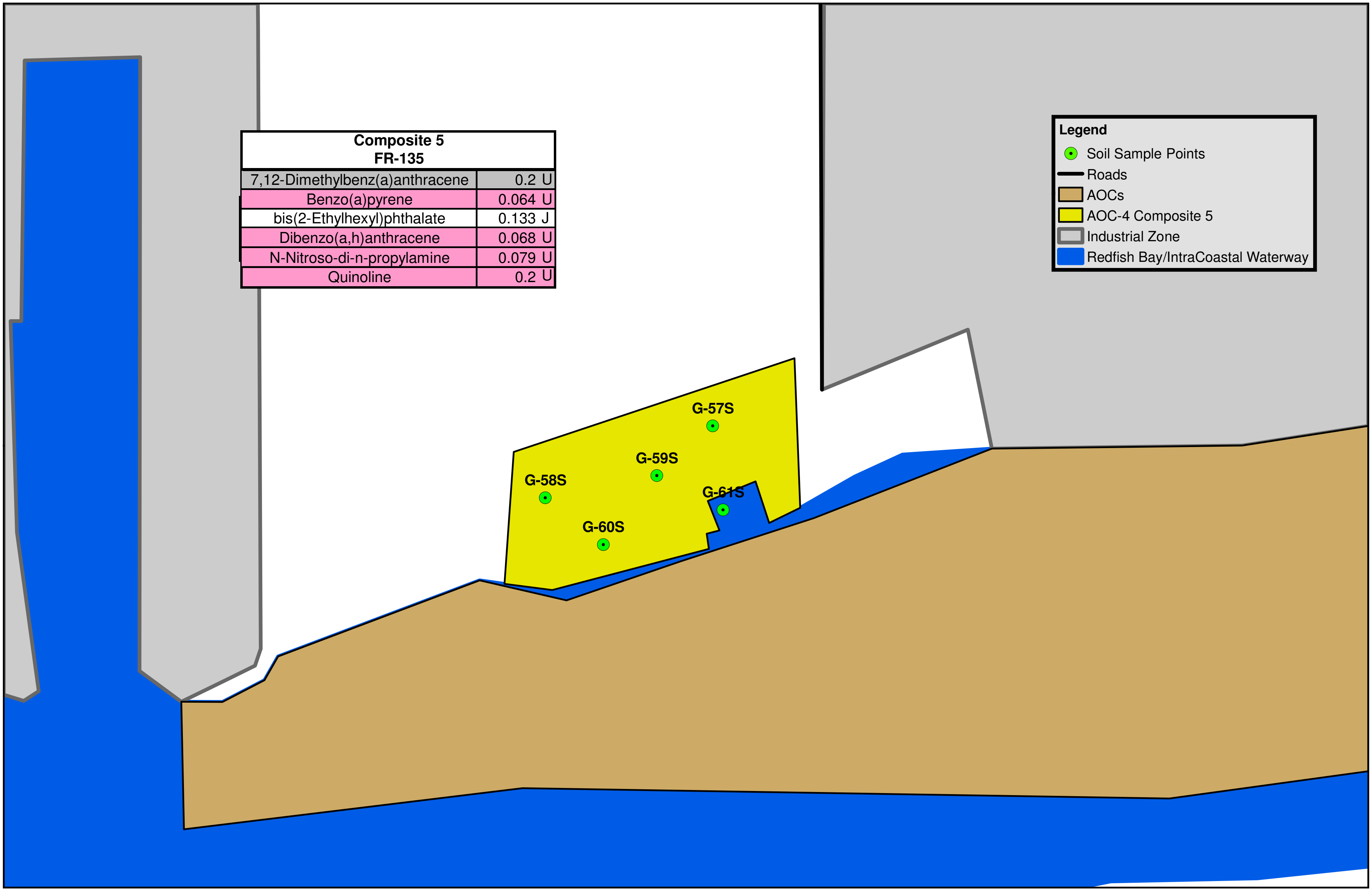
FIGURE

13B



Composite 5 FR-135	
7,12-Dimethylbenz(a)anthracene	0.2 U
Benzo(a)pyrene	0.064 U
bis(2-Ethylhexyl)phthalate	0.133 J
Dibenzo(a,h)anthracene	0.068 U
N-Nitroso-di-n-propylamine	0.079 U
Quinoline	0.2 U

Notes:

1. Results are posted in mg/kg
2. Qualifiers:
   - U = Undetected at the sample detection limit (SDL)
   - J = Concentration greater than the sample detection limit (SDL) but less than the method

SDL Exceeds EPA Screening Level

SDL Exceeds TCEQ Screening Level

N

0 100 200

Feet

DATE DRAWN: 5/7/08	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-4 Human Health SVOC Subsurface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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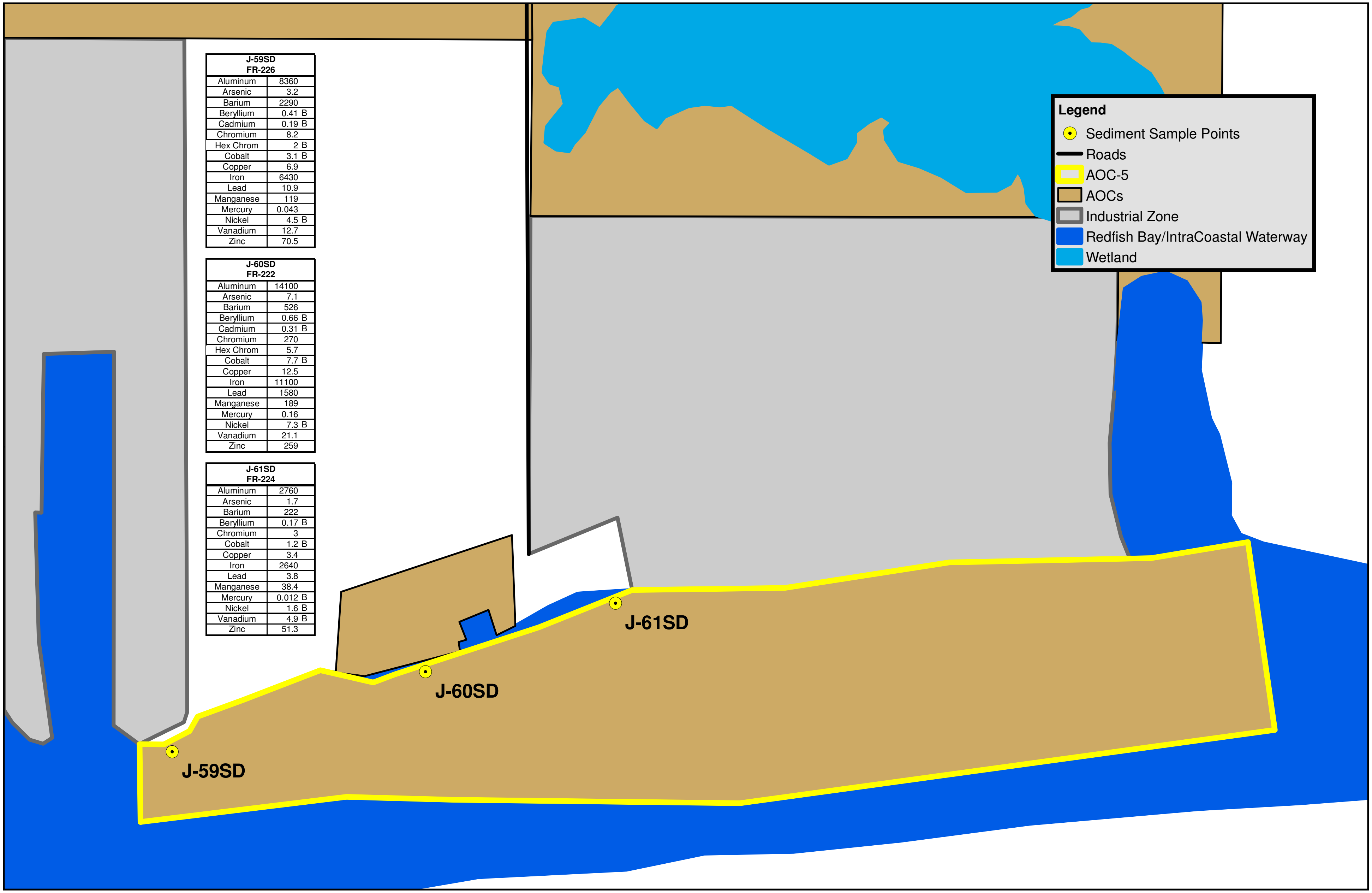
FIGURES

13C



J-59SD FR-226	
Aluminum	8360
Arsenic	3.2
Barium	2290
Beryllium	0.41 B
Cadmium	0.19 B
Chromium	8.2
Hex Chrom	2 B
Cobalt	3.1 B
Copper	6.9
Iron	6430
Lead	10.9
Manganese	119
Mercury	0.043
Nickel	4.5 B
Vanadium	12.7
Zinc	70.5

J-60SD FR-222	
Aluminum	14100
Arsenic	7.1
Barium	526
Beryllium	0.66 B
Cadmium	0.31 B
Chromium	270
Hex Chrom	5.7
Cobalt	7.7 B
Copper	12.5
Iron	11100
Lead	1580
Manganese	189
Mercury	0.16
Nickel	7.3 B
Vanadium	21.1
Zinc	259

J-61SD FR-224	
Aluminum	2760
Arsenic	1.7
Barium	222
Beryllium	0.17 B
Chromium	3
Cobalt	1.2 B
Copper	3.4
Iron	2640
Lead	3.8
Manganese	38.4
Mercury	0.012 B
Nickel	1.6 B
Vanadium	4.9 B
Zinc	51.3

Notes:

1. Results are posted in mg/kg

2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

N

0 150 300
Feet

DATE DRAWN:	DATE REVISED:
5/7/08	4/1/09
DRAFTED BY: C. SEATON	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-5
Human Health
Metal Sediment Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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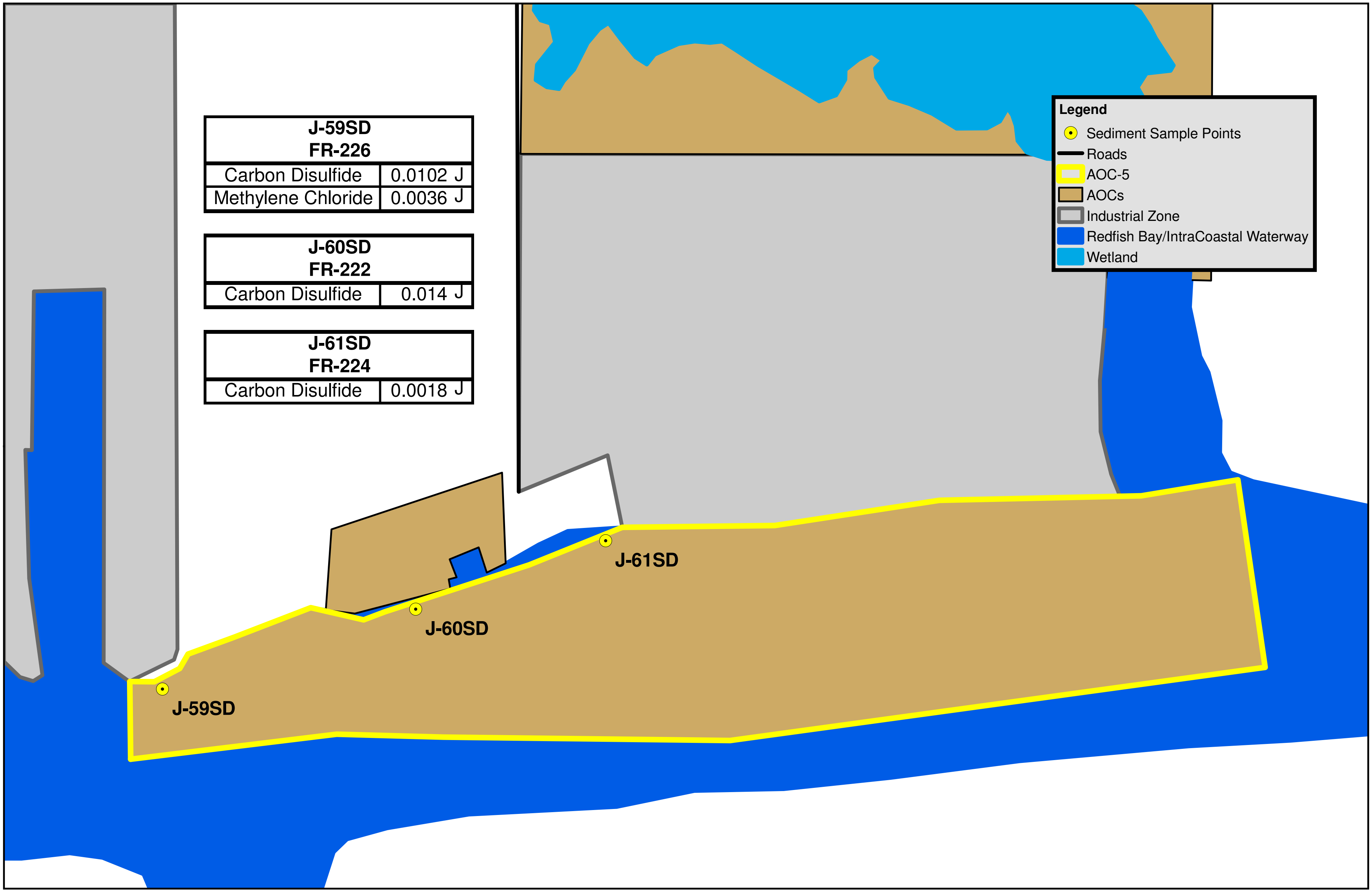
FIGURE
14A



J-59SD FR-226	
Carbon Disulfide	0.0102 J
Methylene Chloride	0.0036 J

J-60SD FR-222	
Carbon Disulfide	0.014 J

J-61SD FR-224	
Carbon Disulfide	0.0018 J

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

J = Concentration greater than the sample detection limit (SDL) but less than the method

DATE DRAWN: 5/7/08	DATE REVISED: 4/1/07	**AOC-5 Human Health VOC Sediment Distribution Map**
DRAFTED BY: C. SEATON		FALCON REFINERY INGLESIDE, SAN PATRICIO COUNTY, TEXAS
CHECKED BY: S. HALASZ		
APPROVED BY:		
PROJ NO. 59752	FILE NAME: Falcon Refinery Base Map	

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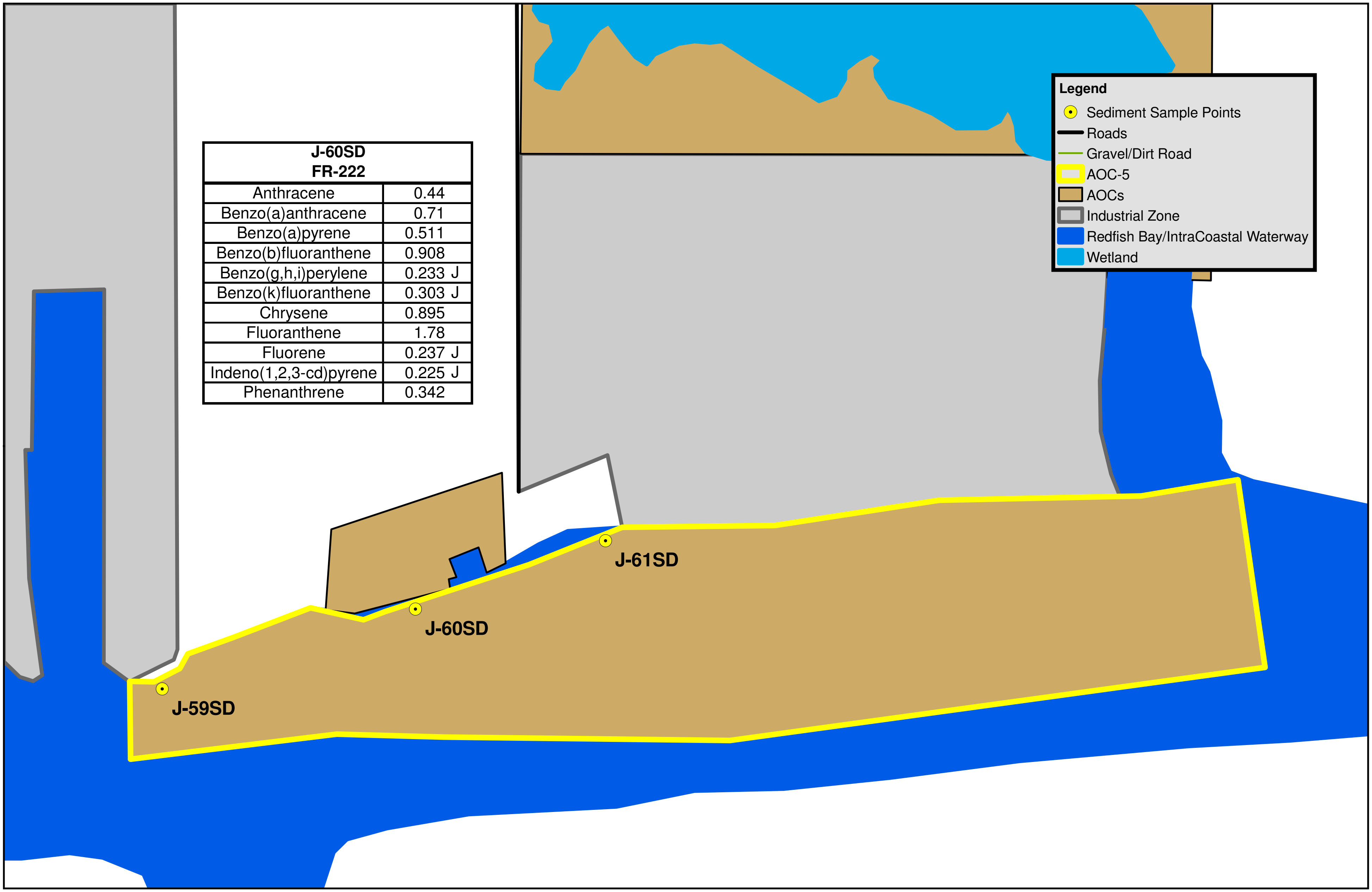
FIGURE
14B



J-60SD FR-222	
Anthracene	0.44
Benzo(a)anthracene	0.71
Benzo(a)pyrene	0.511
Benzo(b)fluoranthene	0.908
Benzo(g,h,i)perylene	0.233 J
Benzo(k)fluoranthene	0.303 J
Chrysene	0.895
Fluoranthene	1.78
Fluorene	0.237 J
Indeno(1,2,3-cd)pyrene	0.225 J
Phenanthrene	0.342

Notes:

1. Results are posted in mg/kg

2. Qualifiers:

J = Concentration greater than the sample detection limit (SDL) but less than the method

N

0 150 300

Feet

DATE DRAWN: 5/7/08 | DATE REVISED: 4/1/09

DRAFTED BY: C. SEATON

CHECKED BY: S. HALASZ

APPROVED BY:

AOC-5
Human Health
SVOC Sediment Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 | FILE NAME: Falcon Refinery Base Map

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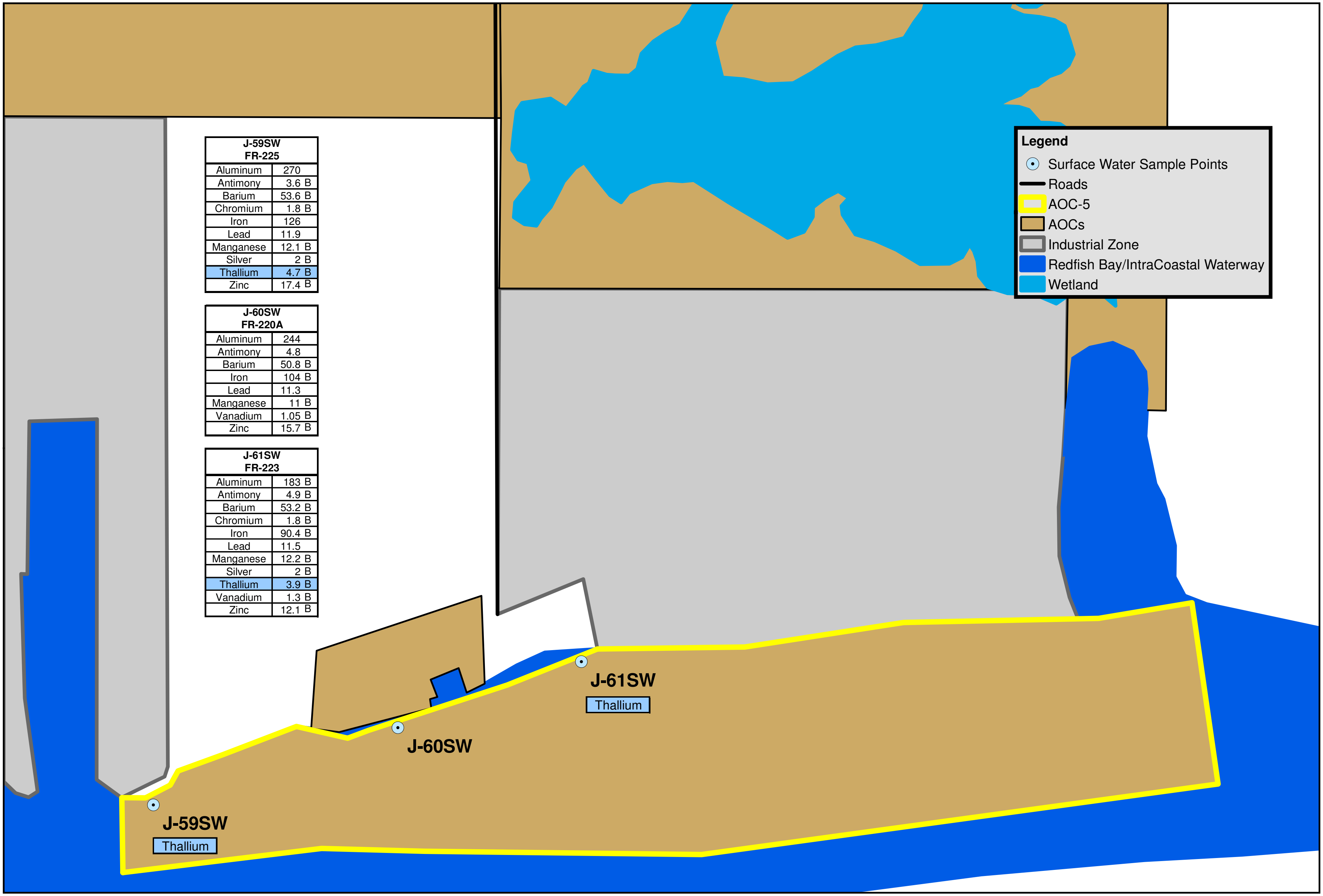
FIGURE

14C



J-59SW FR-225	
Aluminum	270
Antimony	3.6 B
Barium	53.6 B
Chromium	1.8 B
Iron	126
Lead	11.9
Manganese	12.1 B
Silver	2 B
Thallium	4.7 B
Zinc	17.4 B

J-60SW FR-220A	
Aluminum	244
Antimony	4.8
Barium	50.8 B
Iron	104 B
Lead	11.3
Manganese	11 B
Vanadium	1.05 B
Zinc	15.7 B

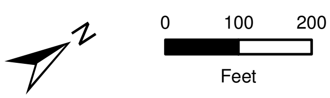
J-61SW FR-223	
Aluminum	183 B
Antimony	4.9 B
Barium	53.2 B
Chromium	1.8 B
Iron	90.4 B
Lead	11.5
Manganese	12.2 B
Silver	2 B
Thallium	3.9 B
Vanadium	1.3 B
Zinc	12.1 B

Notes:

1. Results are posted in µg/l
2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds ^{SW}RBELs



DATE DRAWN: 5/7/08	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-5
Human Health
Metal Surface Water Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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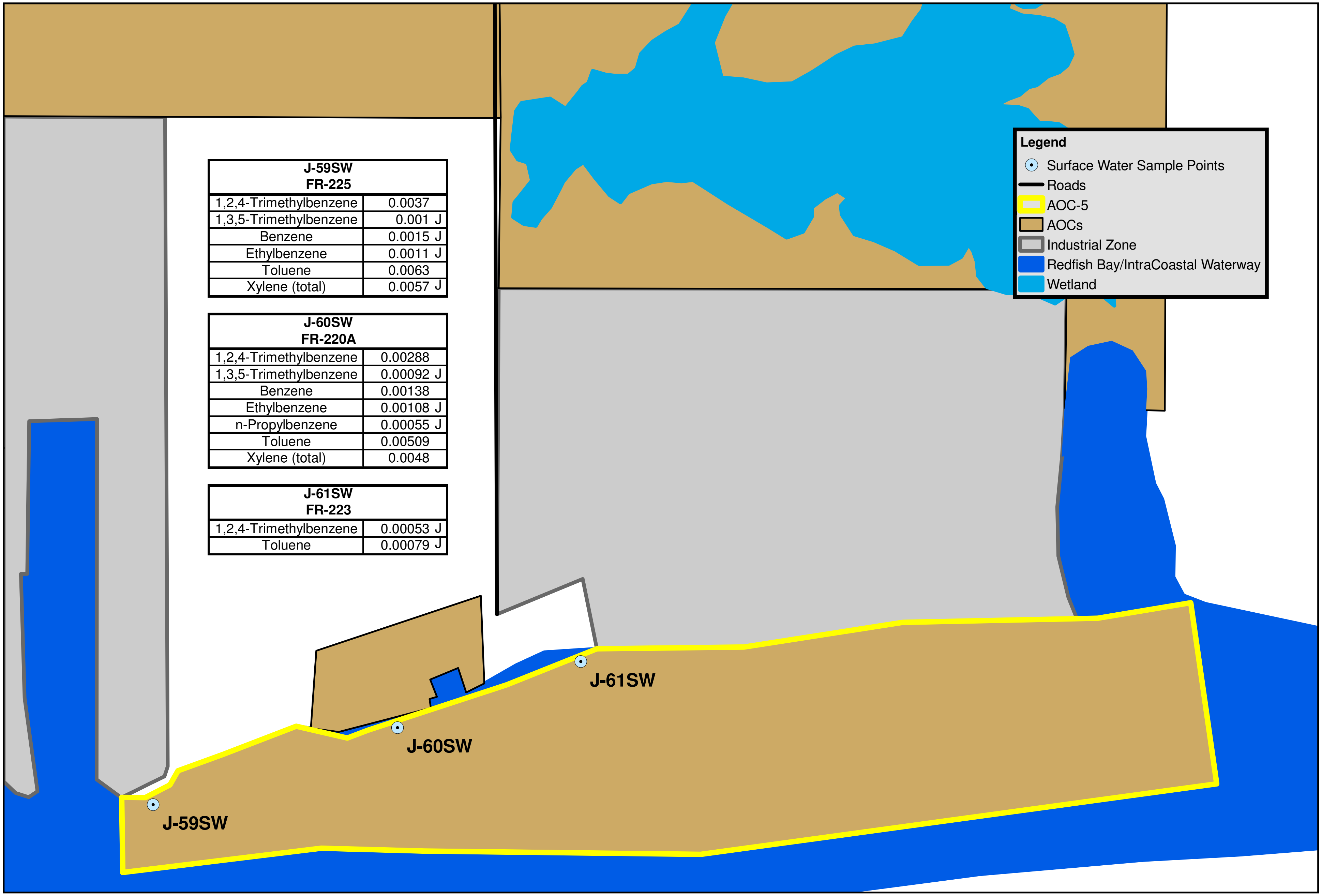
FIGURE
15A



J-59SW FR-225	
1,2,4-Trimethylbenzene	0.0037
1,3,5-Trimethylbenzene	0.001 J
Benzene	0.0015 J
Ethylbenzene	0.0011 J
Toluene	0.0063
Xylene (total)	0.0057 J

J-60SW FR-220A	
1,2,4-Trimethylbenzene	0.00288
1,3,5-Trimethylbenzene	0.00092 J
Benzene	0.00138
Ethylbenzene	0.00108 J
n-Propylbenzene	0.00055 J
Toluene	0.00509
Xylene (total)	0.0048

J-61SW FR-223	
1,2,4-Trimethylbenzene	0.00053 J
Toluene	0.00079 J

Notes:

1. Results are posted in mg/l
2. Qualifiers:

J = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

N

0 80 160

Feet

DATE DRAWN: 5/7/08	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-5
Human Health
VOC Surface Water Distribution Map

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INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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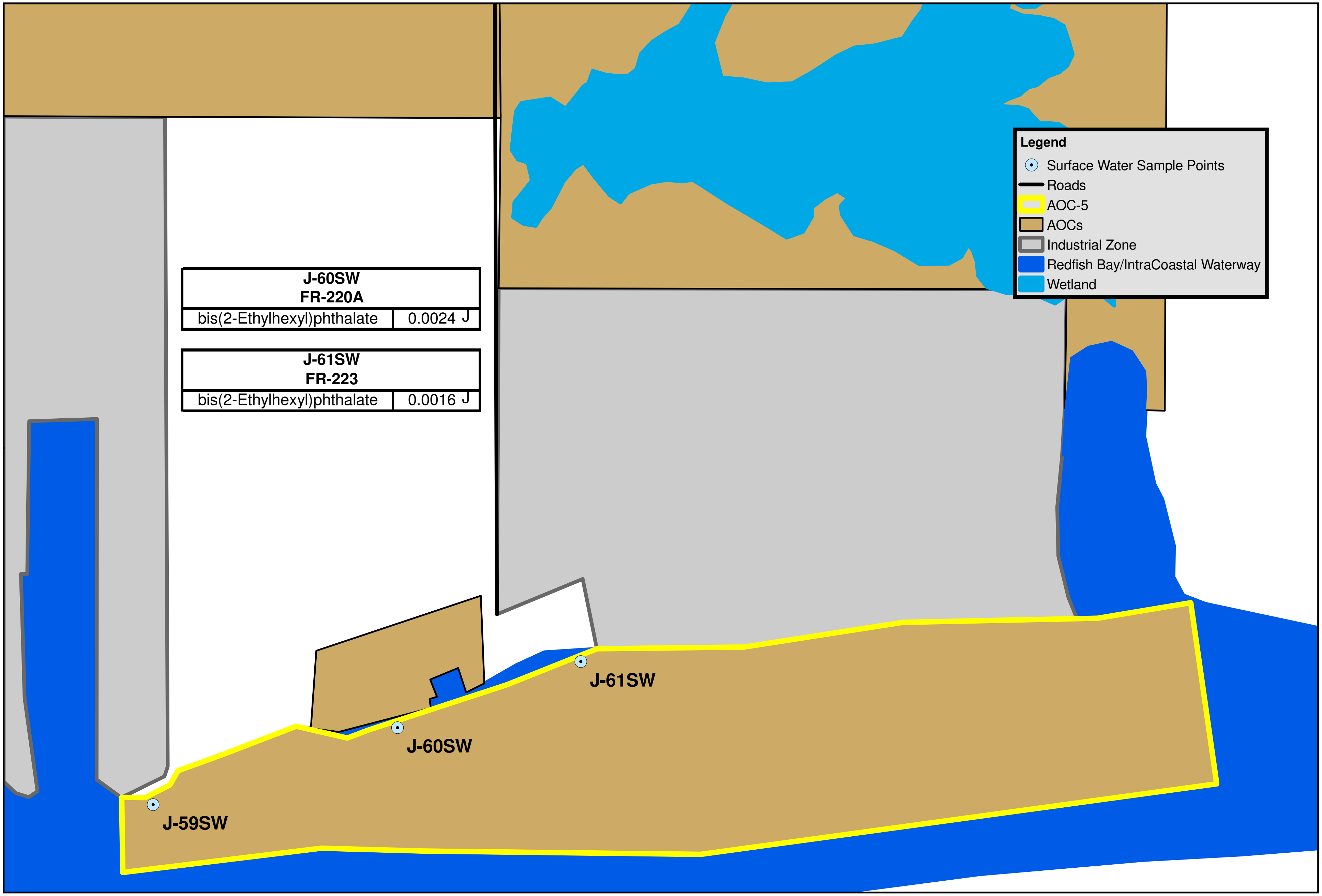
FIGURE
15B



Notes:

1. Results are posted in mg/l
2. Qualifiers:

J = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

N

0 80 160

Feet

DATE DRAWN: 5/7/08	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-5
Human Health
SVOC Surface Water Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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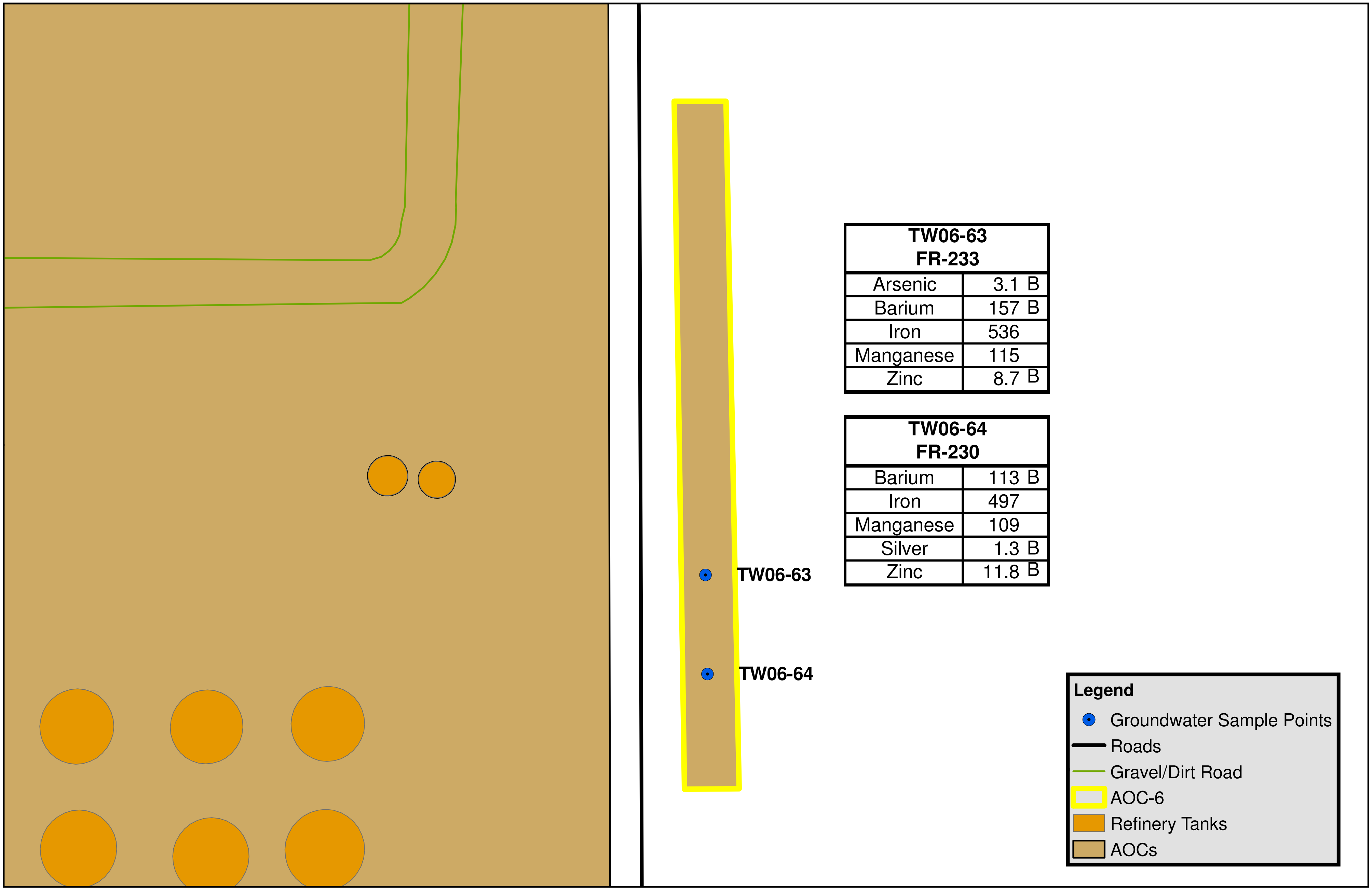
FIGURE
15C



TW06-63 FR-233	
Arsenic	3.1 B
Barium	157 B
Iron	536
Manganese	115
Zinc	8.7 B

TW06-64 FR-230	
Barium	113 B
Iron	497
Manganese	109
Silver	1.3 B
Zinc	11.8 B

Notes:

1. Results are posted in µg/l

2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

0 50 100

Feet

DATE DRAWN: 5/7/08	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-6
Human Health
Metal Groundwater Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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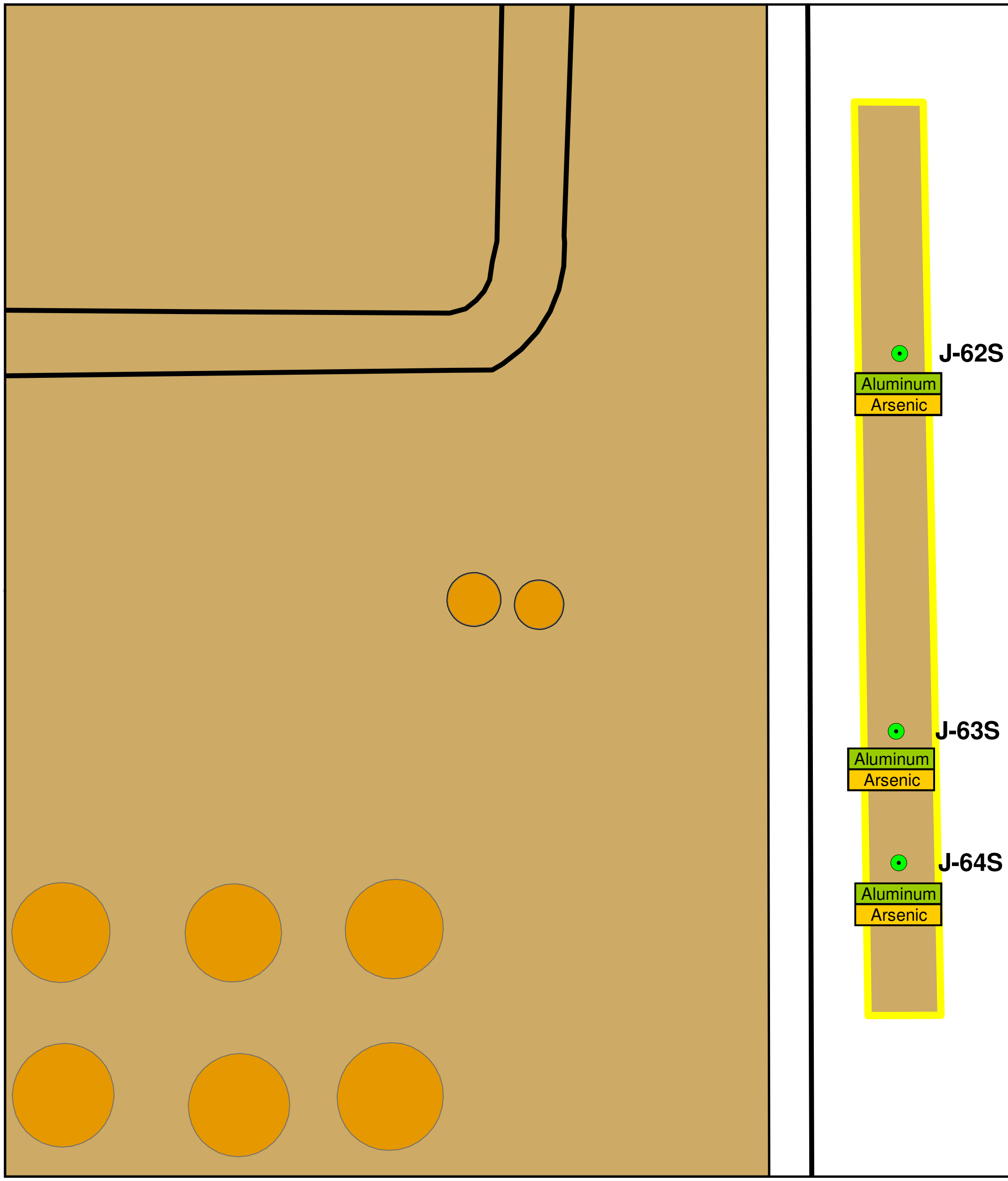
FIGURE

16



J-62S FR-234A	
Aluminum	11750
Arsenic	1.5
Barium	259
Beryllium	0.495
Cadmium	0.17 B
Chromium	12.25
Cobalt	2.75 B
Copper	8.45
Iron	7025
Lead	8.6
Manganese	180
Mercury	0.00405 B
Nickel	6
Selenium	0.795 B
Vanadium	19.45
Zinc	71.25

J-63S FR-231	
Aluminum	9190
Arsenic	2.4
Barium	280
Beryllium	0.43 B
Cadmium	0.13 B
Chromium	10.8
Cobalt	2.4 B
Copper	9.1
Iron	6580
Lead	7.1
Manganese	133
Mercury	0.0067 B
Nickel	7.5
Selenium	0.78 B
Vanadium	32.5
Zinc	69.3

J-64S FR-228	
Aluminum	10600
Arsenic	2.8
Barium	400
Beryllium	0.45 B
Cadmium	0.16 B
Chromium	15.3
Cobalt	2.7 B
Copper	14.6
Iron	7630
Lead	16.5
Manganese	157
Mercury	0.0094 B
Nickel	7.2
Selenium	1.2
Vanadium	20.6
Zinc	111

Legend

- Soil Sample Points
- Roads
- AOC-6
- Refinery Tanks
- AOCs

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Above EPA MSSL
Above TCEQ PCL

N

0 50 100
Feet

DATE DRAWN: 5/7/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-6
Human Health
Metal Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 | FILE NAME: Falcon Refinery Base Map

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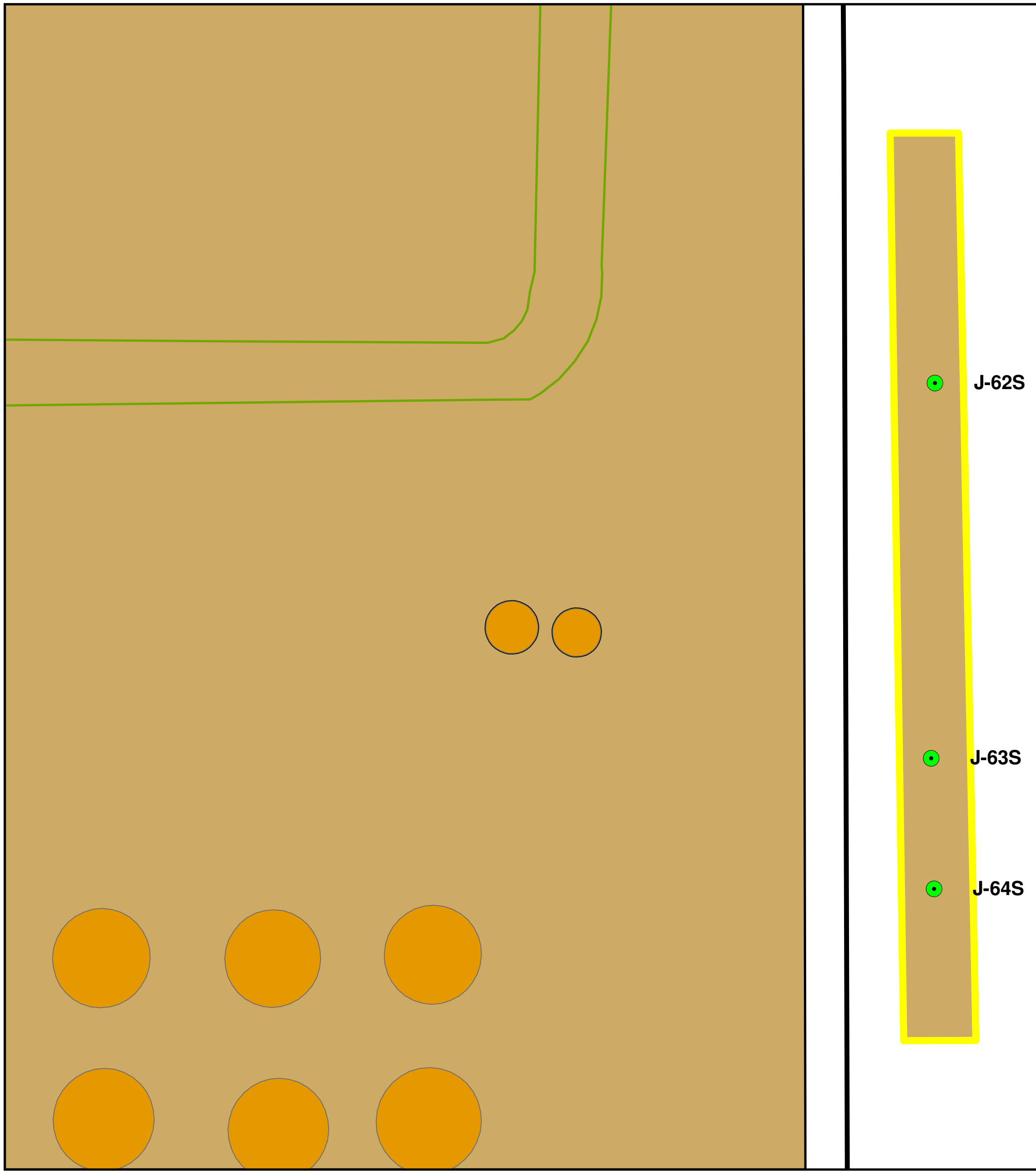
FIGURE
17A



J-62S FR-234A	
1,2,3-Trichloropropane	0.0016 U
Acetone	0.0094 J
Methylene Chloride	0.00295 J

J-63S FR-231	
1,2,3-Trichloropropane	0.0015 U
Methylene Chloride	0.0028 J

J-64S FR-228	
1,2,3-Trichloropropane	0.0015 U
Methylene Chloride	0.003 J

Legend

- Soil Sample Points
- Roads
- Gravel/Dirt Road
- AOC-6
- Refinery Tanks
- AOCs

Notes:

1. Results are posted in mg/kg
2. Qualifiers:
   U = Undetected at the sample detection limit (SDL)
   J = Concentration greater than the sample detection limit (SDL) but less than the method

SDL Exceeds TCEQ Screening Level

N

0 50 100

Feet

DATE DRAWN: 5/7/08	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-6
Human Health
VOC Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 | FILE NAME: Falcon Refinery Base Map

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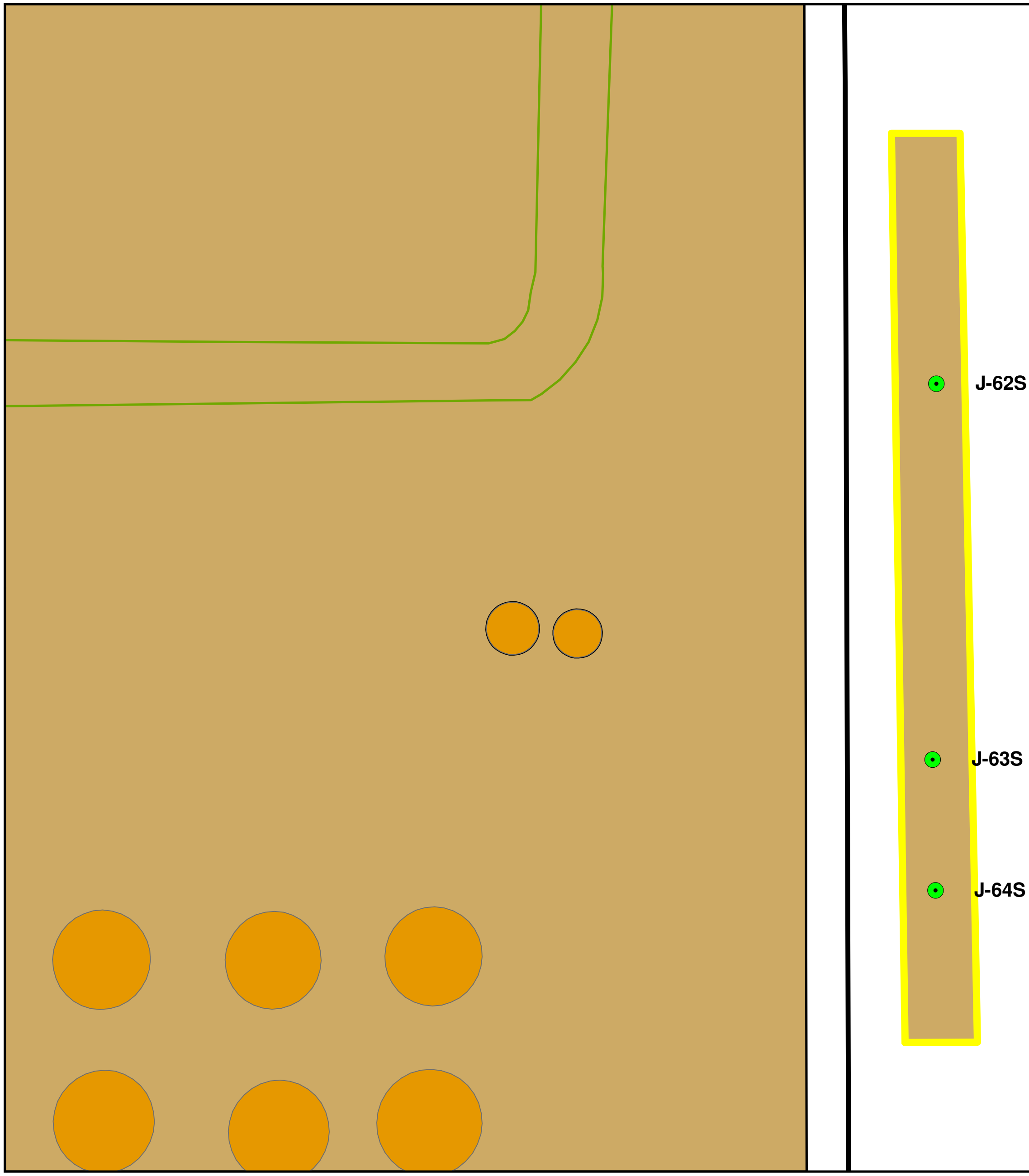
FIGURE
17B



J-62S FR-234A	
4-Bromophenyl phenyl ether	0.63 U
7,12-Dimethylbenz(a)anthracene	1.09 U
Benzenethiol	1.09 U
Benzo(a)anthracene	0.41 U
Benzo(a)pyrene	0.36 U
Benzo(b)fluoranthene	0.46 U
bis(2-Chloroethyl)ether	0.23 U
Dibenzo(a,h)anthracene	0.39 U
Hexachlorobenzene	0.36 U
Indeno(1,2,3-cd)pyrene	0.43 U
N-Nitroso-di-n-propylamine	0.44 U
Quinoline	1.09 U

J-63S FR-231	
7,12-Dimethylbenz(a)anthracene	0.36 U
Benzo(a)anthracene	0.13 U
Benzo(a)pyrene	0.12 U
Benzo(b)fluoranthene	0.15 U
Dibenzo(a,h)anthracene	0.12 U
N-Nitroso-di-n-propylamine	0.14 U
Quinoline	0.36 U

J-64S FR-228	
7,12-Dimethylbenz(a)anthracene	0.38 U
Benzo(a)anthracene	0.14 U
Benzo(a)pyrene	0.12 U
Benzo(b)fluoranthene	0.16 U
Dibenzo(a,h)anthracene	0.13 U
N-Nitroso-di-n-propylamine	0.15 U
Quinoline	0.38 U

Legend

- Soil Sample Points
- Roads
- Gravel/Dirt Road
- AOC-6
- Refinery Tanks
- AOCs

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

   U = Undetected at the sample detection limit (SDL)

- SDL Exceeds EPA Screening Level
- SDL Exceeds TCEQ Screening Level
- SDL Exceeds Both EPA and TCEQ Screening Level

N

0 50 100

Feet

DATE DRAWN:	DATE REVISED:
5/7/08	4/1/09
DRAFTED BY: C. SEATON	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-6
Human Health
SVOC Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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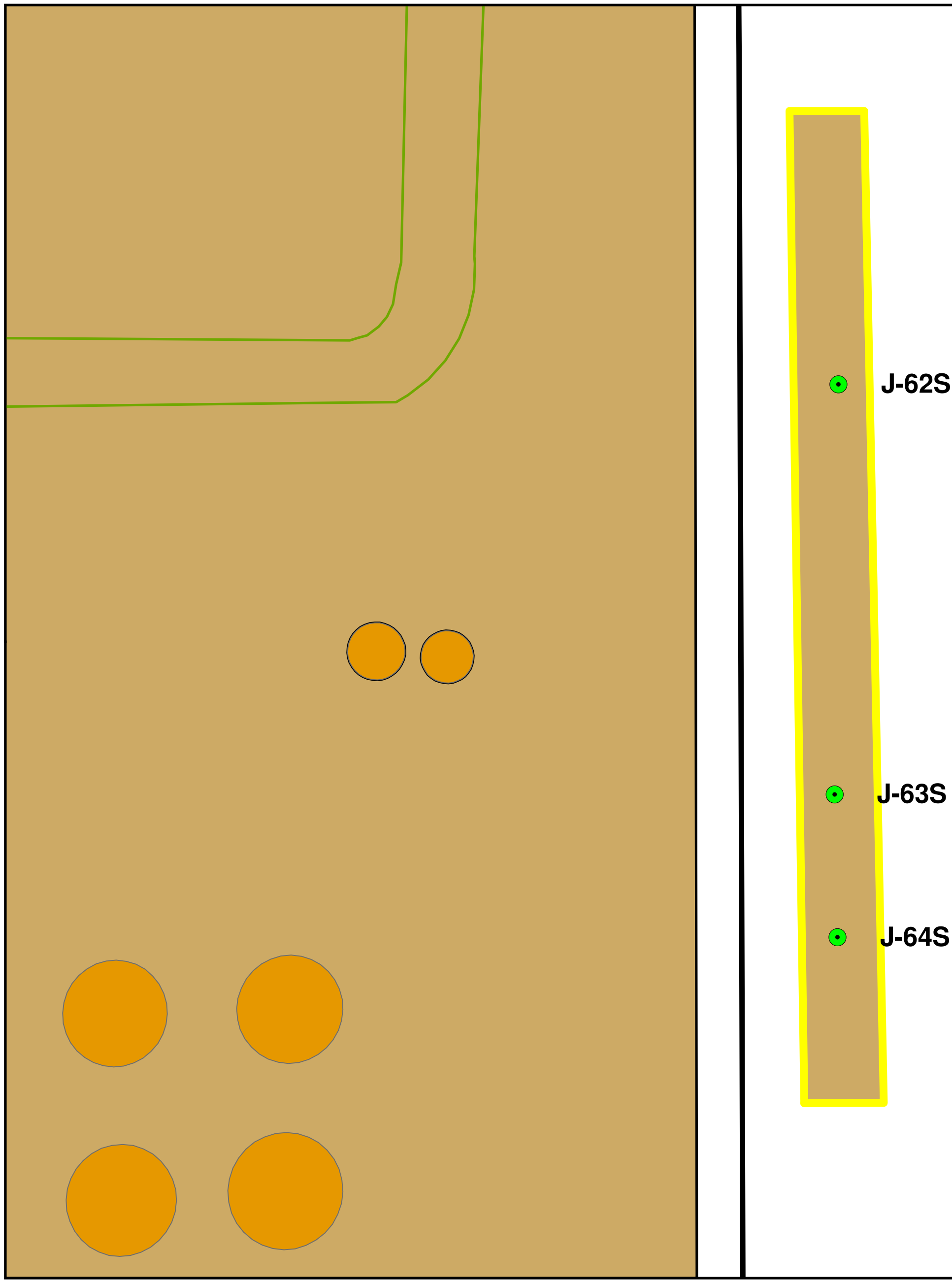
FIGURE
17C



J-62S FR-236	
Aluminum	2660
Barium	21.5 B
Beryllium	0.14 B
Chromium	2.1
Cobalt	0.2 B
Copper	1.2 B
Iron	956
Lead	2.6
Manganese	5.2
Mercury	0.025
Nickel	0.39 B
Vanadium	2.4 B
Zinc	3.7

J-63S FR-232	
Aluminum	4340
Arsenic	0.35 B
Barium	39.6
Beryllium	0.22 B
Chromium	4
Cobalt	0.3 B
Copper	1.9 B
Iron	1500
Lead	3.1
Manganese	7.5
Mercury	0.0064 B
Nickel	0.74 B
Vanadium	3.6 B
Zinc	5.8

J-64S FR-229	
Aluminum	1420
Barium	20.1 B
Beryllium	0.075 B
Chromium	2.3
Hex Chrom	1.5 B
Copper	1.5 B
Iron	737
Lead	2.1
Manganese	4.5
Mercury	0.0083 B
Nickel	0.25 B
Vanadium	1.6 B
Zinc	3

Legend

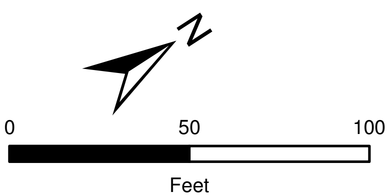
- Soil Sample Points
- Roads
- Gravel/Dirt Road
- AOC-6
- Refinery Tanks
- AOCs

Notes:

1. Results are posted in mg/kg

2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)



DATE DRAWN: 5/7/08	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-6
Human Health
Metal Subsurface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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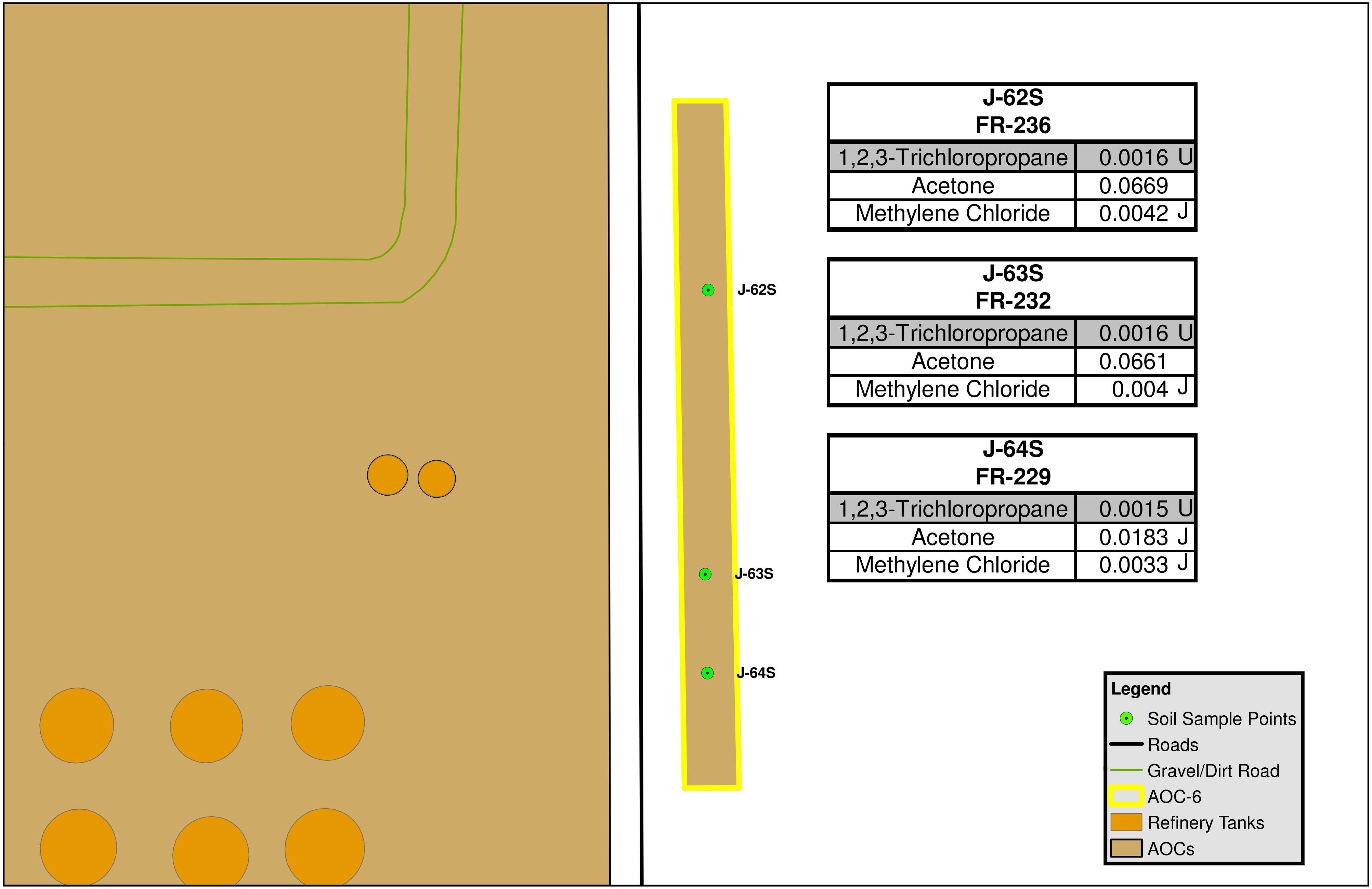
FIGURE
18A



J-62S FR-236	
1,2,3-Trichloropropane	0.0016 U
Acetone	0.0669
Methylene Chloride	0.0042 J

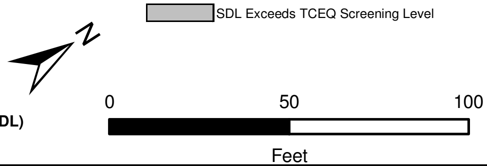
J-63S FR-232	
1,2,3-Trichloropropane	0.0016 U
Acetone	0.0661
Methylene Chloride	0.004 J

J-64S FR-229	
1,2,3-Trichloropropane	0.0015 U
Acetone	0.0183 J
Methylene Chloride	0.0033 J

Notes:

1. Results are posted in mg/kg
2. Qualifiers:
   U = Undetected at the sample detection limit (SDL)
   J = Concentration greater than the sample detection limit (SDL) but less than the method

SDL Exceeds TCEQ Screening Level



DATE DRAWN: 5/7/08	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-6
Human Health
VOC Subsurface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 | FILE NAME: Falcon Refinery Base Map

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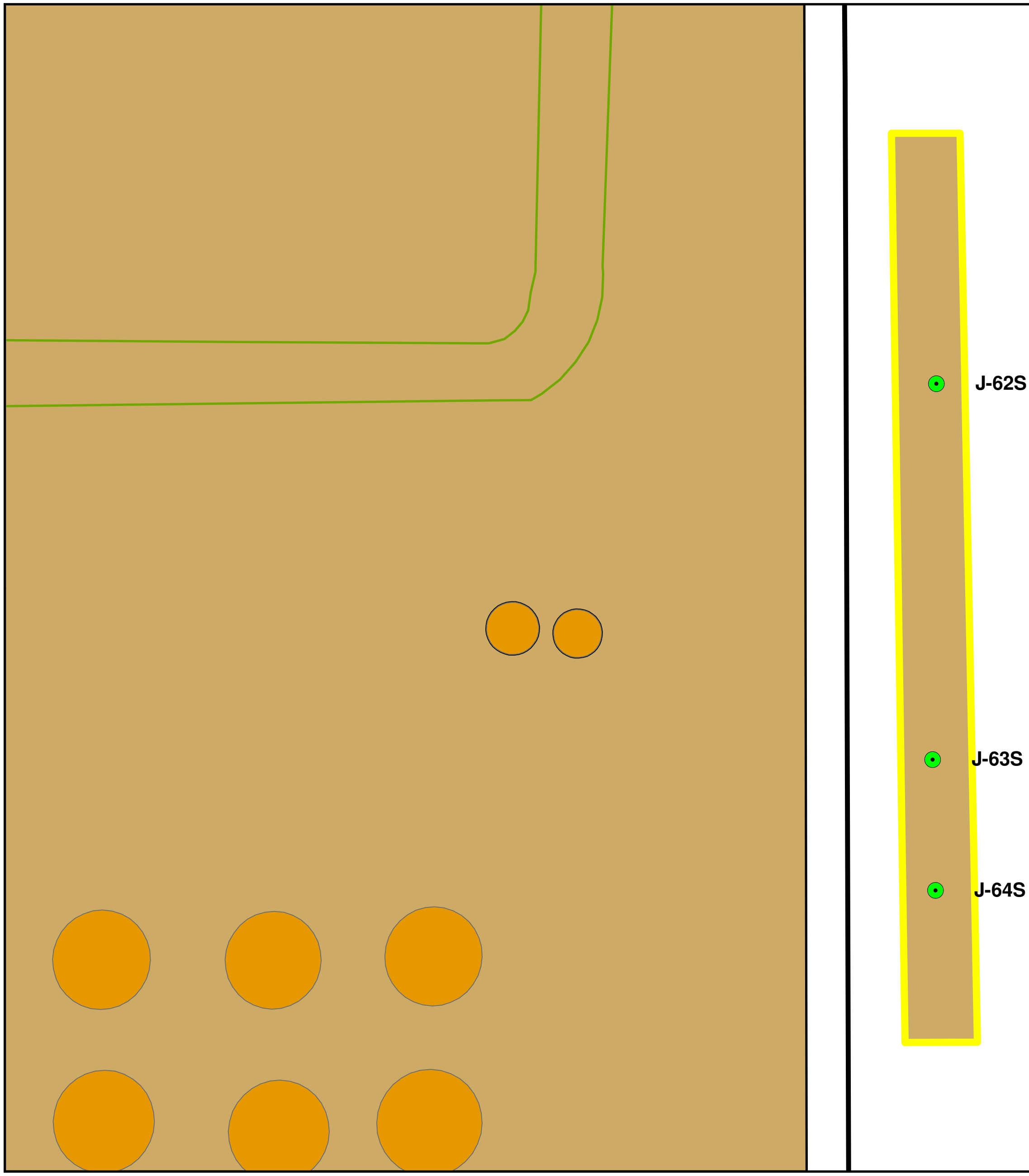
FIGURE
18B



J-62S FR-236	
7,12-Dimethylbenz(a)anthracene	0.20 U
Benzo(a)pyrene	0.064 U
Dibenzo(a,h)anthracene	0.068 U
N-Nitroso-di-n-propylamine	0.079 U
Quinoline	0.20 U

J-63S FR-232	
7,12-Dimethylbenz(a)anthracene	0.19 U
Benzo(a)pyrene	0.062 U
Dibenzo(a,h)anthracene	0.067 U
N-Nitroso-di-n-propylamine	0.077 U
Quinoline	0.19 U

J-64S FR-229	
7,12-Dimethylbenz(a)anthracene	0.20 U
Benzo(a)pyrene	0.065 U
Dibenzo(a,h)anthracene	0.069 U
N-Nitroso-di-n-propylamine	0.080 U
Quinoline	0.20 U

Legend

- Soil Sample Points
- Roads
- Gravel/Dirt Road
- AOC-6
- Refinery Tanks
- AOCs

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

SDL Exceeds EPA Screening Level

SDL Exceeds TCEQ Screening Level

0 50 100

Feet

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AOC-6
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SVOC Subsurface Soil Distribution Map

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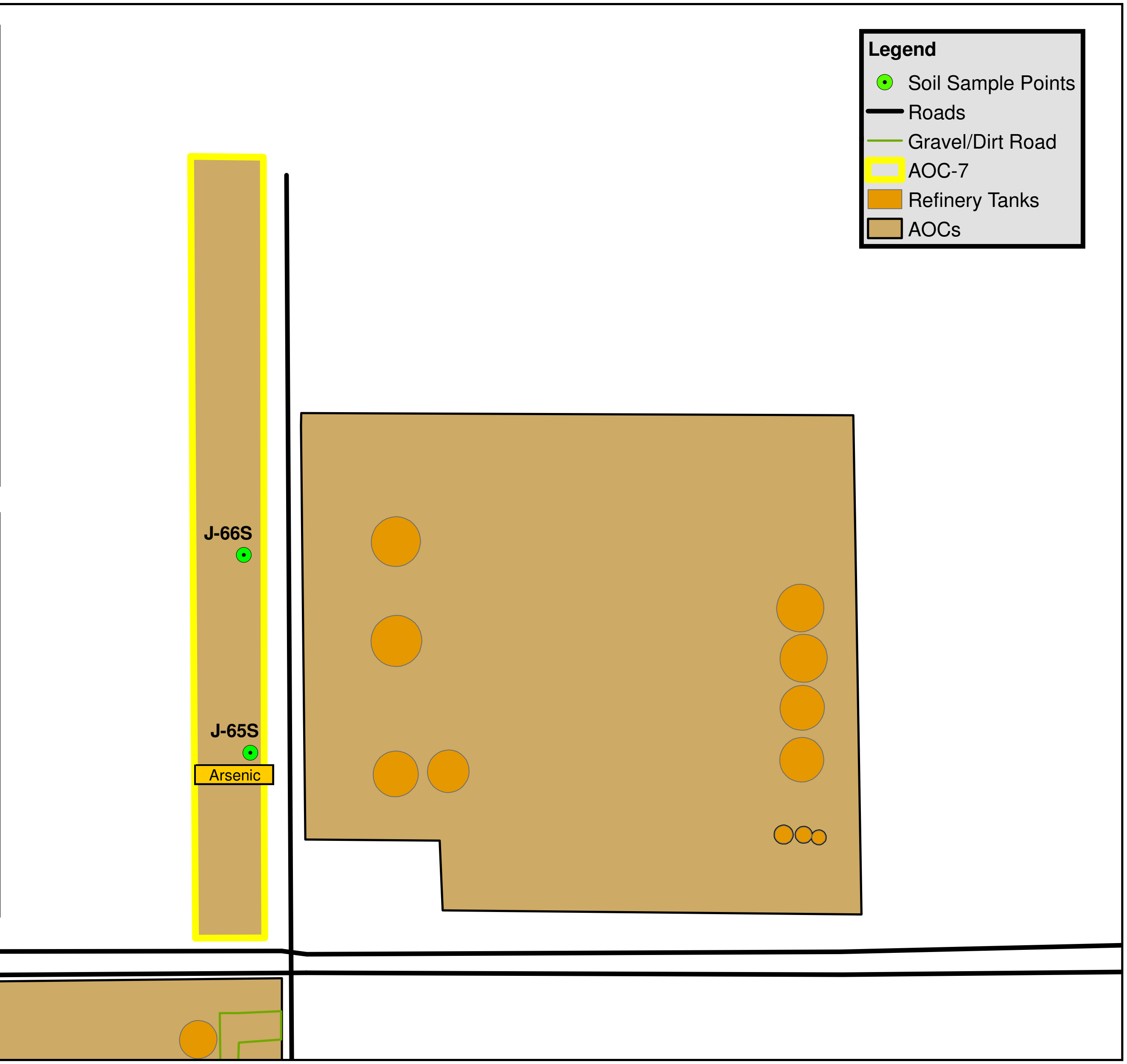
FIGURE
18C

J-65S FR-237	
Aluminum	1620
Arsenic	0.57 B
Barium	28.5
Beryllium	0.072 B
Chromium	1.4
Hex Chrom	1.3 B
Cobalt	0.24 B
Copper	1.9 B
Iron	885
Lead	6.5
Manganese	14.5
Nickel	0.39 B
Vanadium	1.7 B
Zinc	23

J-66S FR-239	
Aluminum	775
Arsenic	0.34 B
Barium	21.8
Beryllium	0.054 B
Chromium	1.1
Copper	1.9 B
Iron	565
Lead	7.9
Manganese	24.3
Nickel	0.27 B
Vanadium	1.1 B
Zinc	21.2



Notes:

1. Results are posted in mg/kg

2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Above EPA MSSL

0 150 300

Feet

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APPROVED BY:	

AOC-7
Human Health
Metal Surface Soil Distribution Map

FALCON REFINERY
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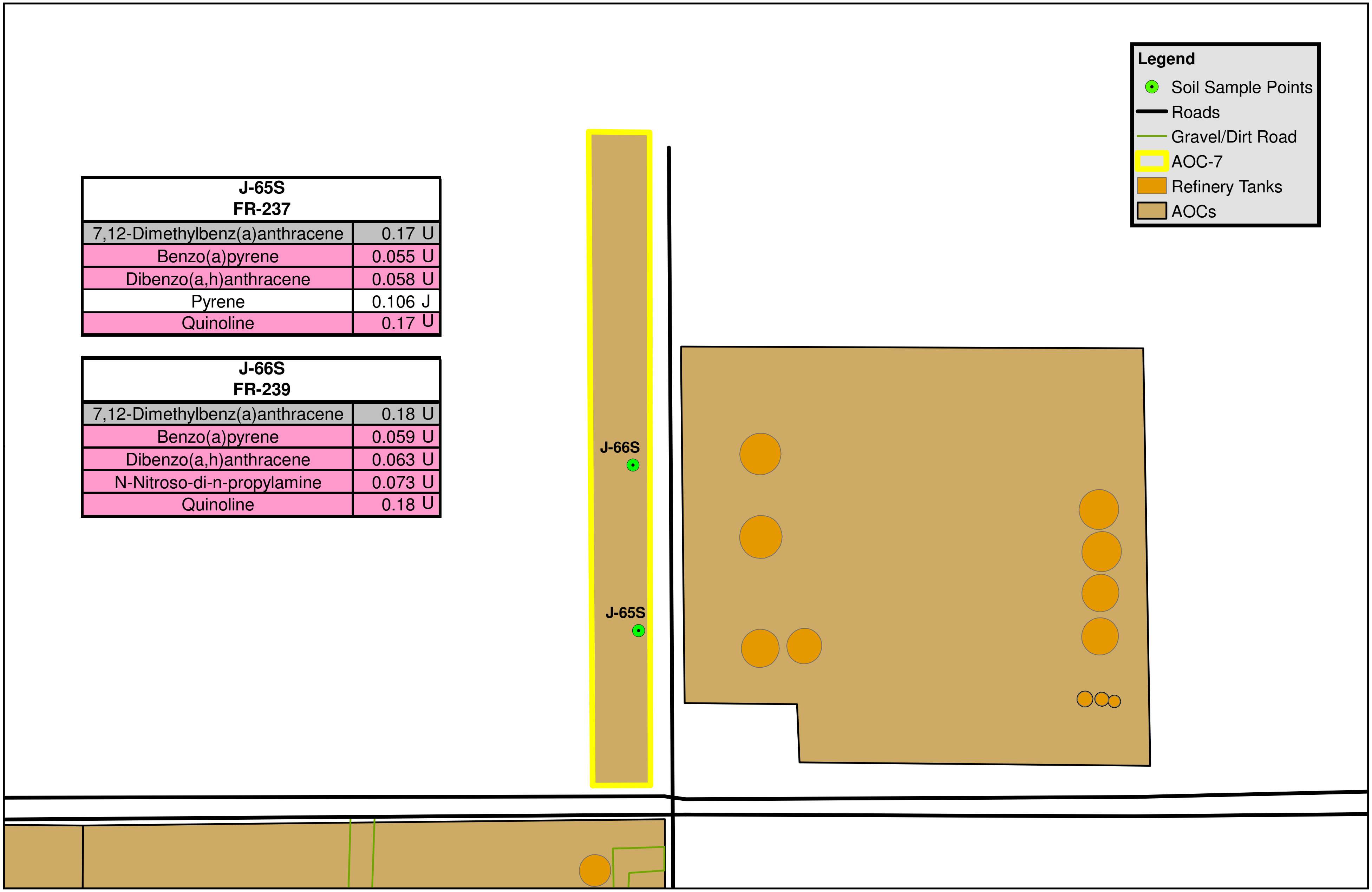
FIGURE

19A



J-65S FR-237	
7,12-Dimethylbenz(a)anthracene	0.17 U
Benzo(a)pyrene	0.055 U
Dibenzo(a,h)anthracene	0.058 U
Pyrene	0.106 J
Quinoline	0.17 U

J-66S FR-239	
7,12-Dimethylbenz(a)anthracene	0.18 U
Benzo(a)pyrene	0.059 U
Dibenzo(a,h)anthracene	0.063 U
N-Nitroso-di-n-propylamine	0.073 U
Quinoline	0.18 U

Notes:

1. Results are posted in mg/kg
2. Qualifiers:
   U = Undetected at the sample detection limit (SDL)
   J = Concentration greater than the sample detection limit (SDL) but less than the method

SDL Exceeds EPA Screening Level
SDL Exceeds TCEQ Screening Level

N

0 150 300

Feet

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SVOC Surface Soil Distribution Map

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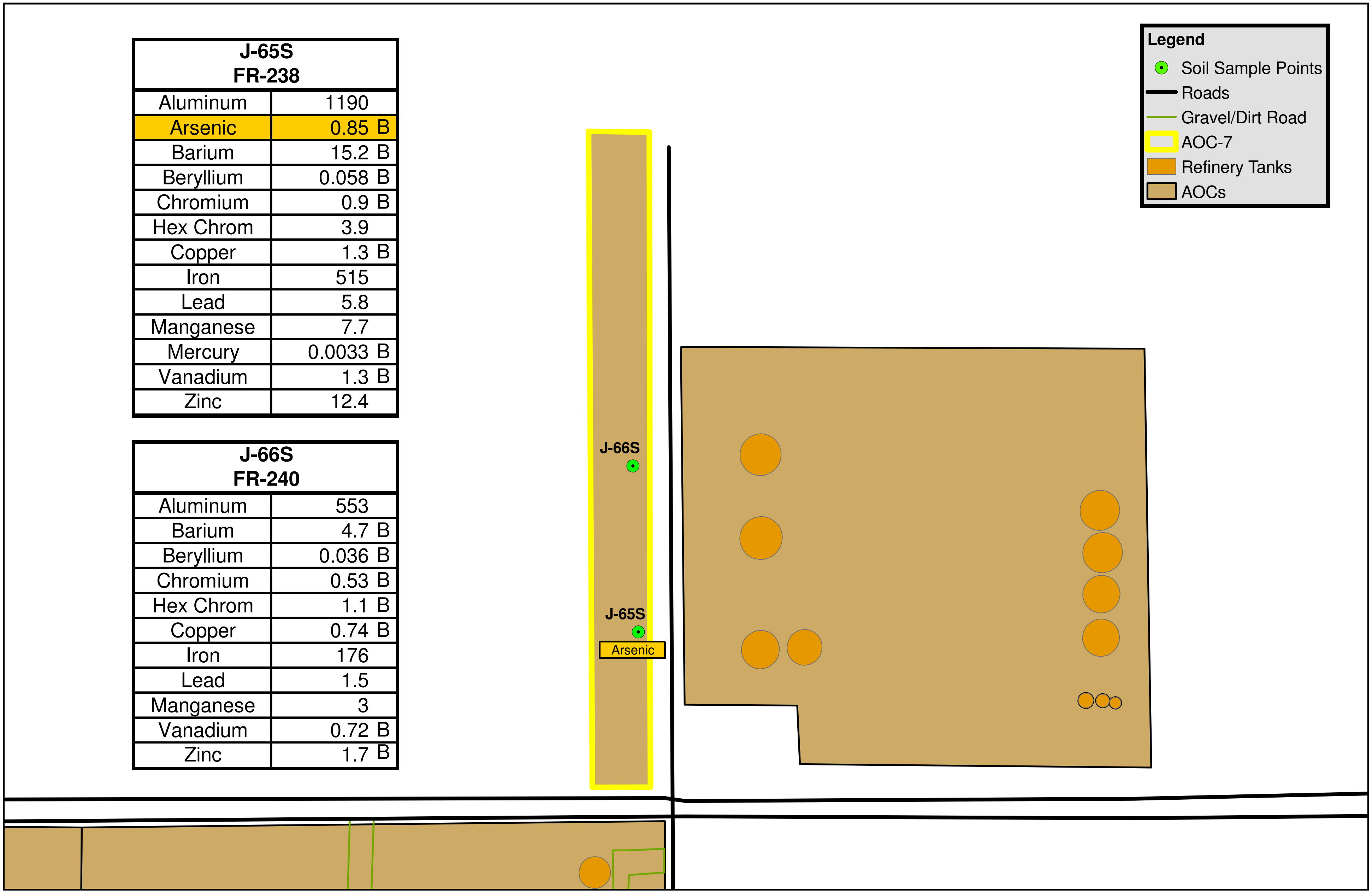
FIGURE
19B

J-65S FR-238	
Aluminum	1190
Arsenic	0.85 B
Barium	15.2 B
Beryllium	0.058 B
Chromium	0.9 B
Hex Chrom	3.9
Copper	1.3 B
Iron	515
Lead	5.8
Manganese	7.7
Mercury	0.0033 B
Vanadium	1.3 B
Zinc	12.4

J-66S FR-240	
Aluminum	553
Barium	4.7 B
Beryllium	0.036 B
Chromium	0.53 B
Hex Chrom	1.1 B
Copper	0.74 B
Iron	176
Lead	1.5
Manganese	3
Vanadium	0.72 B
Zinc	1.7 B



Notes:

1. Results are posted in mg/kg
   Hex Chrom posted in mg/l

2. Qualifiers:

   B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Above EPA MSSL

N

0 150 300

Feet

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APPROVED BY:	

AOC-7
Human Health
Metal Subsurface Soil Distribution Map

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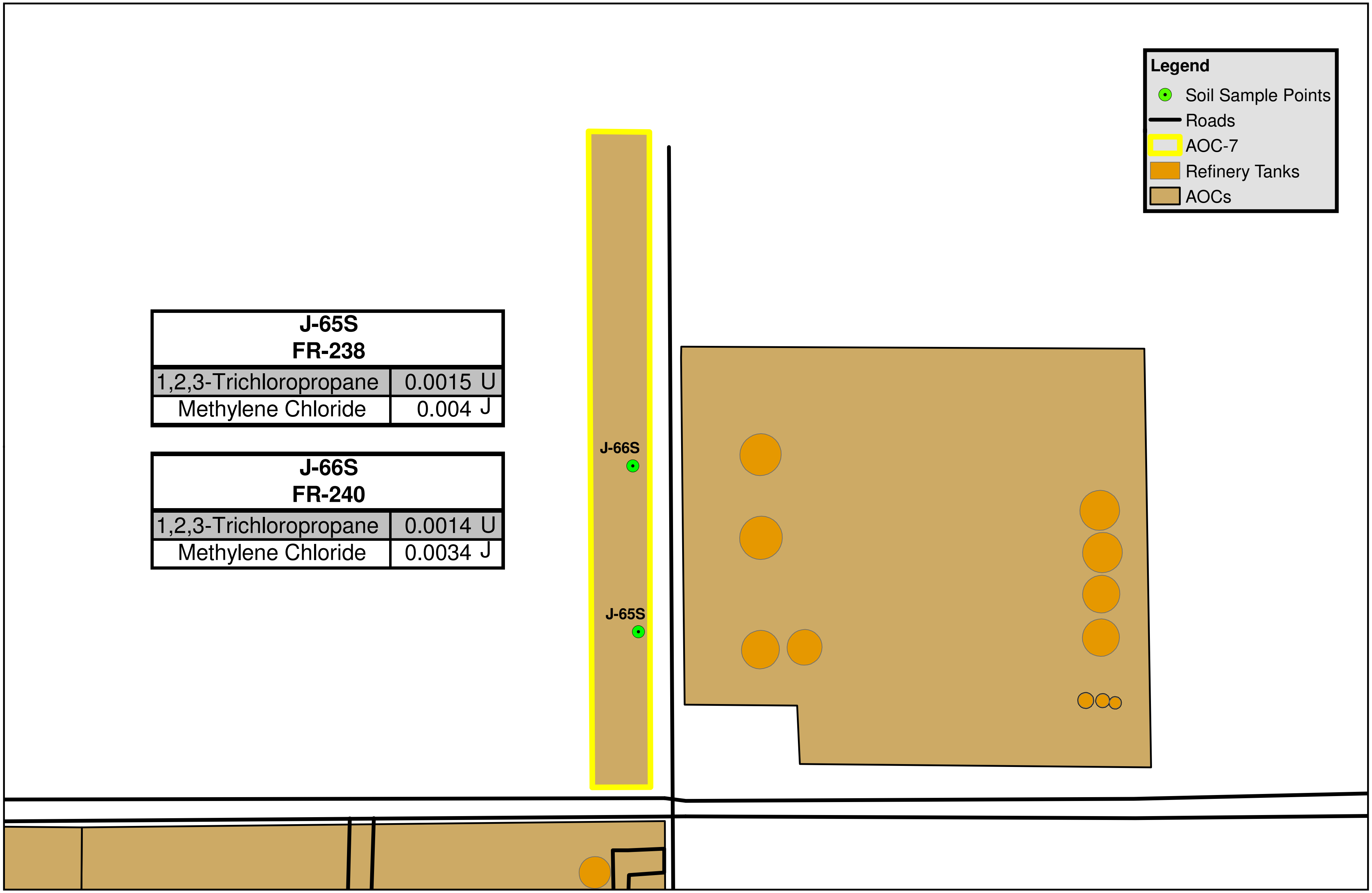
FIGURE
20A



J-65S FR-238	
1,2,3-Trichloropropane	0.0015 U
Methylene Chloride	0.004 J

J-66S FR-240	
1,2,3-Trichloropropane	0.0014 U
Methylene Chloride	0.0034 J

Notes:

1. Results are posted in mg/kg

2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

J = Concentration greater than the sample detection limit (SDL) but less than the method

SDL Exceeds TCEQ Screening Level

N

0 150 300

Feet

DATE DRAWN: 5/7/08	DATE REVISED: 4/1/09
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AOC-7
Human Health
VOC Subsurface Soil Distribution Map

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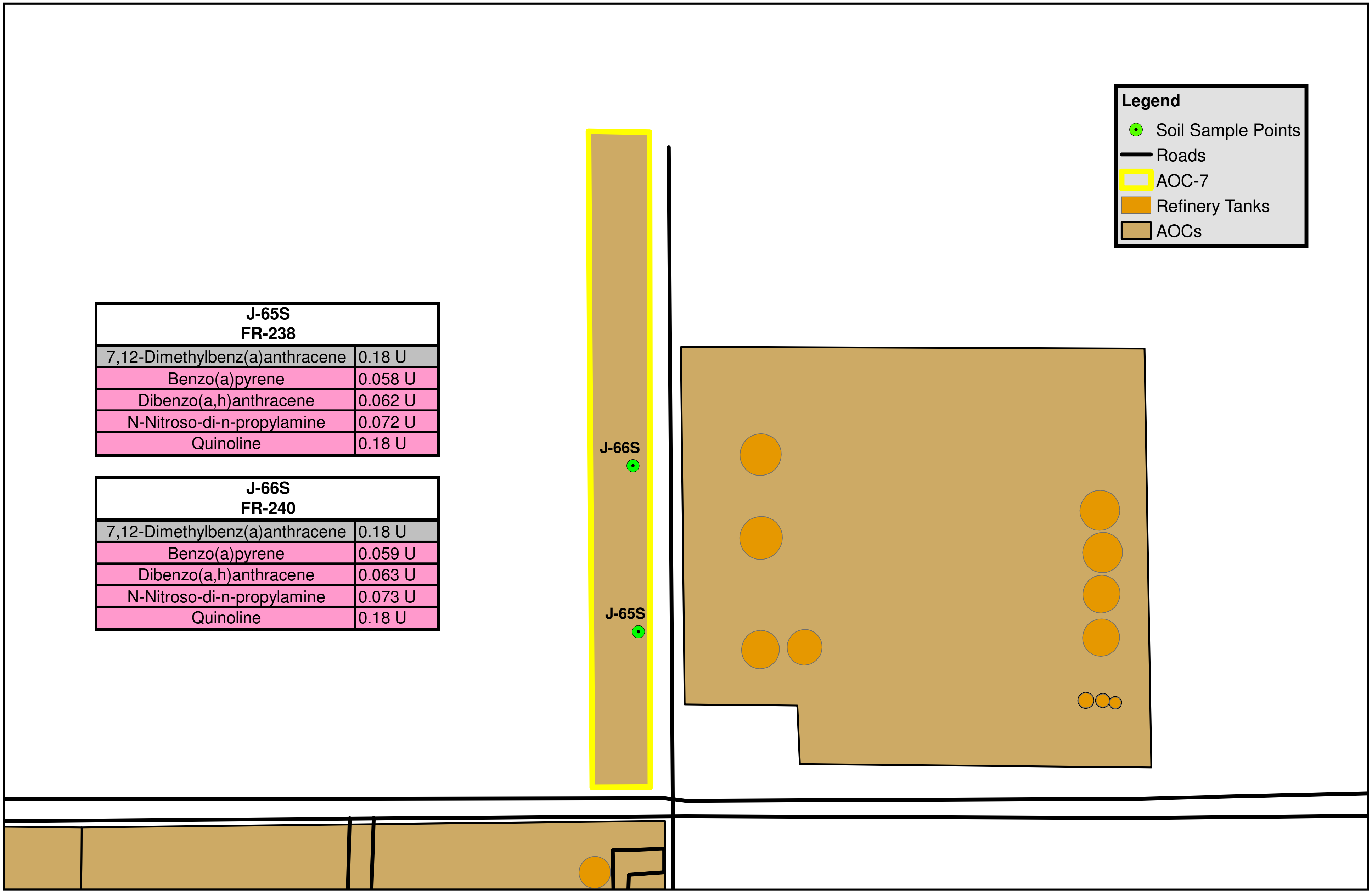
FIGURE
20B



J-65S FR-238	
7,12-Dimethylbenz(a)anthracene	0.18 U
Benzo(a)pyrene	0.058 U
Dibenzo(a,h)anthracene	0.062 U
N-Nitroso-di-n-propylamine	0.072 U
Quinoline	0.18 U

J-66S FR-240	
7,12-Dimethylbenz(a)anthracene	0.18 U
Benzo(a)pyrene	0.059 U
Dibenzo(a,h)anthracene	0.063 U
N-Nitroso-di-n-propylamine	0.073 U
Quinoline	0.18 U

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

SDL Exceeds TCEQ Screening Level

SDL Exceeds EPA Screening Level

N

0 150 300

Feet

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DRAFTED BY: C. SEATON	
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SVOC Subsurface Soil Distribution Map

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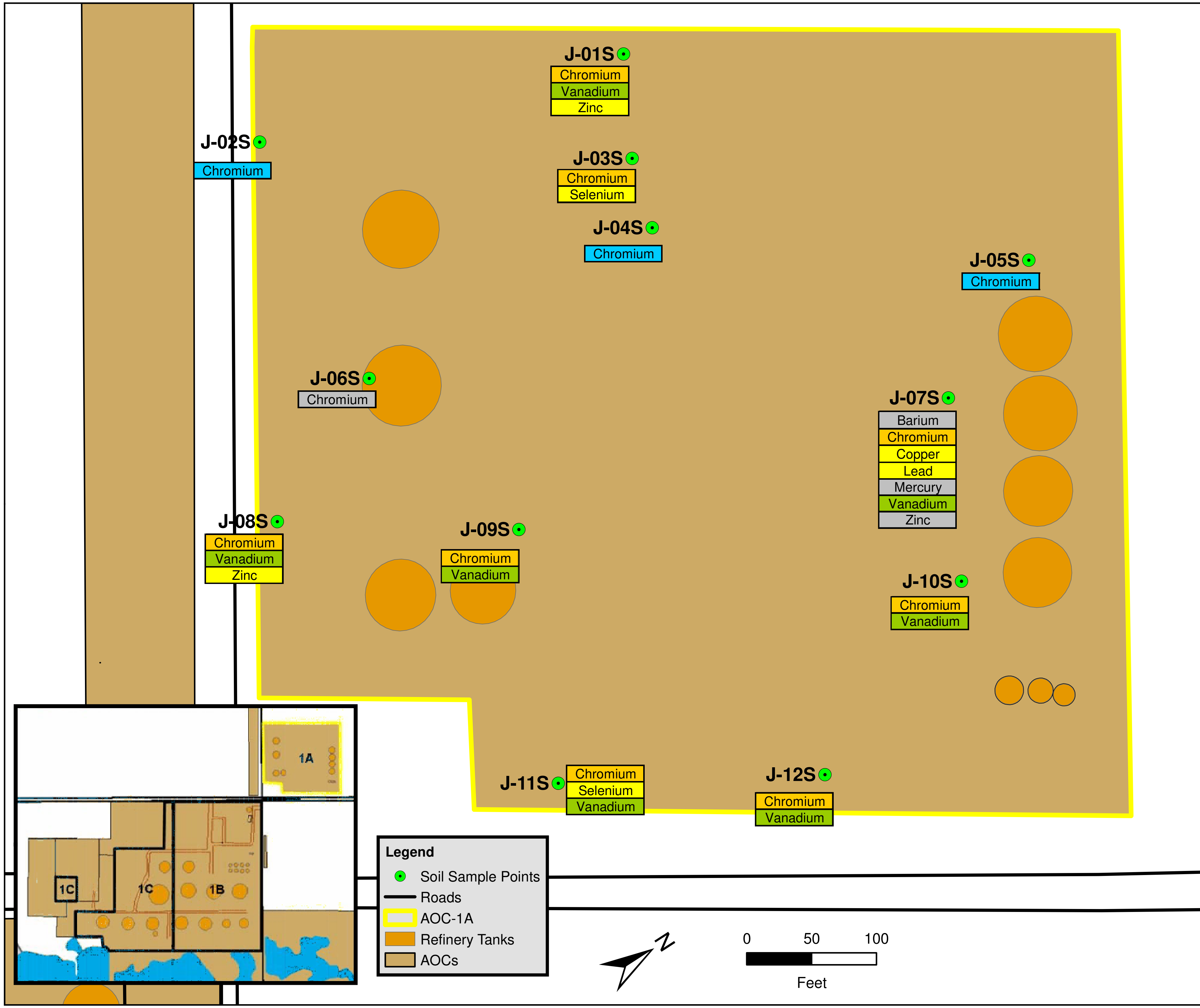
FIGURE

20C



J-01 S FR-013	
Aluminum	3010
Arsenic	0.51 B
Barium	86.4
Beryllium	0.1 B
Chromium	2.8
Cobalt	0.74 B
Copper	1.7 B
Iron	1760
Lead	7
Manganese	66.4
Mercury	0.0083 B
Nickel	1 B
Selenium	0.33 U
Vanadium	4.7 B
Zinc	40.7

J-05 S FR-033	
Aluminum	1250
Arsenic	0.29 B
Barium	19 B
Beryllium	0.087 B
Chromium	0.77 B
Cobalt	0.47 B
Copper	0.93 B
Iron	1740
Lead	4.8
Manganese	11.5
Mercury	0.0014 B
Nickel	0.56 B
Selenium	0.31 U
Vanadium	1.7 B
Zinc	10.4

J-09 S FR-025	
Aluminum	5460
Arsenic	1.2
Barium	25.9
Beryllium	0.24 B
Chromium	4.5
Hex Chrom	1.4
Cobalt	1.3 B
Copper	2.7
Iron	4280
Lead	8.9
Manganese	43.6
Mercury	0.013 B
Nickel	2.2 B
Vanadium	7.7
Zinc	16.6

J-02 S FR-016	
Aluminum	820
Barium	31.4
Beryllium	0.023 B
Chromium	0.9
Hex Chrom	1.3
Copper	0.99 B
Iron	540
Lead	4.6
Manganese	21.1
Mercury	0.0069 B
Nickel	0.29 B
Selenium	0.26 B
Vanadium	1.1 B
Zinc	23.6

J-06 S FR-019A	
Aluminum	609
Barium	6.25 B
Chromium	50.5 B
Copper	0.685 B
Iron	331
Lead	2.15
Manganese	9.3
Mercury	0.00535 B
Vanadium	0.985 B
Zinc	3.1

J-10 S FR-027	
Aluminum	1670
Arsenic	0.31 B
Barium	13.9 B
Beryllium	0.094 B
Chromium	2.9
Hex Chrom	1.9
Cobalt	0.43 B
Copper	0.86 B
Iron	2170
Lead	6.9
Manganese	21.5
Mercury	0.0047 B
Nickel	0.76 B
Vanadium	2.4 B
Zinc	22.8

J-03 S FR-009A	
Aluminum	509.5
Barium	24.3 B
Chromium	1.25
Copper	1.025 B
Iron	444.5
Lead	4.4
Manganese	11.9
Mercury	0.0096 B
Nickel	0.33 B
Selenium	0.305 B
Vanadium	1.15 B
Zinc	11.8

J-07 S FR-030	
Aluminum	2900
Antimony	0.54 B
Arsenic	2
Barium	1250
Beryllium	0.13 B
Cadmium	0.56
Chromium	13.3
Cobalt	2.5 B
Copper	23.5
Iron	4500
Lead	80.6
Manganese	39.6
Mercury	0.74
Nickel	4.3 B
Vanadium	5.1 B
Zinc	232

J-11 S FR-001	
Aluminum	14300
Arsenic	2.6
Barium	165
Beryllium	0.49
Chromium	11.3
Hex Chrom	3.1
Cobalt	3.3 B
Copper	5.1
Iron	7560
Lead	6
Manganese	121
Mercury	0.0037 B
Nickel	5.1
Selenium	0.37 B
Vanadium	22.3
Zinc	25.2

J-04 S FR-007	
Aluminum	786
Arsenic	0.23 B
Barium	23.4
Chromium	0.92 B
Copper	0.93 B
Iron	480
Lead	3.6
Manganese	15.7
Mercury	0.007 B
Nickel	0.35 B
Vanadium	1.3 B
Zinc	8.7

J-08 S FR-022	
Aluminum	5020
Arsenic	0.83 B
Barium	91.8
Beryllium	0.2 B
Chromium	3.6
Cobalt	1.3 B
Copper	3.2
Iron	3560
Lead	8.3
Manganese	102
Mercury	0.0014 B
Nickel	2.1 B
Vanadium	6.1
Zinc	80.3

J-12 S FR-004	
Aluminum	3550
Arsenic	0.57 B
Barium	36
Beryllium	0.092 B
Chromium	2.3
Cobalt	0.61 B
Copper	1.1 B
Iron	1860
Lead	3.4
Manganese	37.3
Mercury	0.0065 B
Nickel	1.3 B
Vanadium	5.1
Zinc	6.1

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

   U = Undetected at the sample detection limit (SDL)

   B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

- Exceeds Earthworm Limit
- Exceeds Plant Limit
- Exceeds Median Background Limit
- Exceeds Earthworm and Plant Limits
- Exceeds Earthworm, Plant, and Median Background Limits
- SDL Exceeds Median Background Screening Level

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1A Ecological Metal Surface Soil Distribution Map

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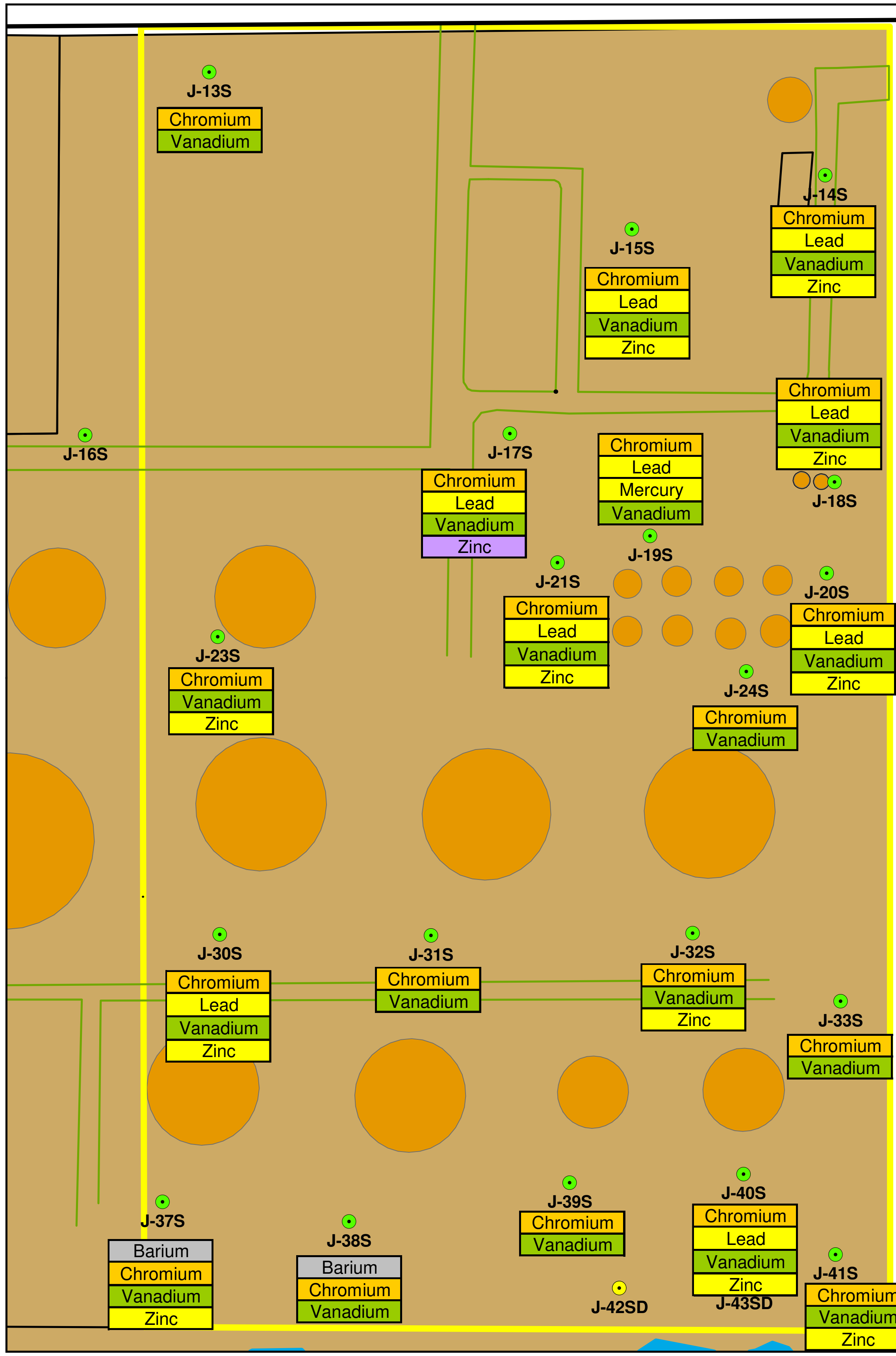
FIGURE
21A



J-13 S FR-064	
Aluminum	2590
Arsenic	0.22 B
Barium	13.7 B
Beryllium	0.041 B
Chromium	1.4
Cobalt	0.2 B
Copper	1 B
Iron	928
Lead	2.6
Manganese	10
Nickel	0.27 B
Vanadium	2.4 B
Zinc	17.2

J-14 S FR-061	
Aluminum	2710
Arsenic	0.66 B
Barium	88.9
Beryllium	0.049 B
Cadmium	0.17 B
Chromium	5.1
Cobalt	1.3 B
Copper	10.7
Iron	3820
Lead	55.8
Manganese	47.3
Mercury	0.0054 B
Nickel	1.7 B
Vanadium	4.1 B
Zinc	92.6

J-15 S FR-035	
Aluminum	1440
Arsenic	2.6
Barium	26.9
Beryllium	0.078 B
Chromium	7.4
Cobalt	0.36 B
Copper	5.7
Iron	2430
Lead	18.9
Manganese	26.4
Mercury	0.011 B
Nickel	1.1 B
Vanadium	2.1 B
Zinc	31.1

J-17 S FR-046	
Aluminum	7070
Arsenic	2
Barium	200
Beryllium	0.19 B
Cadmium	0.23 B
Chromium	9
Cobalt	1.7 B
Copper	8.1
Iron	8120
Lead	16.1
Manganese	146
Mercury	0.024
Nickel	8.6
Vanadium	10.6
Zinc	143

J-18 S FR-050	
Aluminum	3030
Arsenic	0.58 B
Barium	64.5
Beryllium	0.056 B
Cadmium	0.12 B
Chromium	2.8
Cobalt	0.62 B
Copper	2.5 B
Iron	2010
Lead	80.7
Manganese	49.4
Mercury	0.0088 B
Nickel	1.2 B
Vanadium	4.1 B
Zinc	35

J-19 S FR-039A	
Aluminum	4375
Arsenic	1.8
Barium	93.95
Beryllium	0.2 B
Chromium	3.8
Cobalt	1.45 B
Copper	3.25
Iron	3095
Lead	19.75
Manganese	49.4
Mercury	0.049
Nickel	1.8 B
Vanadium	5.25
Zinc	26.15

J-20 S FR-044	
Aluminum	4570
Arsenic	0.86 B
Barium	61.5
Beryllium	0.22 B
Chromium	4
Cobalt	1.1 B
Copper	3.6
Iron	4620
Lead	17.1
Manganese	73.6
Mercury	0.013 B
Nickel	3.4 B
Vanadium	5.8
Zinc	30.2

J-21 S FR-037	
Aluminum	4470
Arsenic	0.93 B
Barium	67.1
Beryllium	0.2 B
Chromium	8.3
Cobalt	1.3 B
Copper	2.5 B
Iron	3050
Lead	17.7
Manganese	77
Mercury	0.016 B
Nickel	4.1
Vanadium	4.9 B
Zinc	39.5

J-23 S FR-054	
Aluminum	8090
Arsenic	1.7
Barium	66.6
Beryllium	0.23 B
Chromium	6.9
Hex Chrom	1.8
Cobalt	1.8 B
Copper	3.6
Iron	4900
Lead	9.9
Manganese	141
Mercury	0.012 B
Nickel	3.3 B
Vanadium	9.6
Zinc	44.1

J-24 S FR-042	
Aluminum	2110
Arsenic	0.35 B
Barium	36.1
Beryllium	0.11 B
Chromium	1.6
Cobalt	0.53 B
Copper	2.2 B
Iron	1560
Lead	7.2
Manganese	41
Mercury	0.026
Nickel	0.81 B
Vanadium	2.3 B
Zinc	22.2

J-30 S FR-094	
Aluminum	14400
Arsenic	3.1
Barium	98.6
Beryllium	0.52 B
Cadmium	0.14 B
Chromium	10.4
Cobalt	2.5 B
Copper	6.9
Iron	8740
Lead	23.8
Manganese	143
Mercury	0.024
Nickel	5.2
Selenium	0.31 U
Vanadium	16.6
Zinc	79

J-31 S FR-099A	
Aluminum	15650
Arsenic	1.6
Barium	61.7
Beryllium	0.46 B
Chromium	9.6
Cobalt	2.2 B
Copper	4.7
Iron	8115
Lead	14.75
Manganese	77.5
Mercury	0.0215
Nickel	4.55 B
Vanadium	17.25
Zinc	26.05

J-32 S FR-096	
Aluminum	14200
Arsenic	2.5
Barium	160
Beryllium	0.52 B
Chromium	8.9
Cobalt	3 B
Copper	5.2
Iron	7850
Lead	11.6
Manganese	191
Mercury	0.007 B
Nickel	5.3
Vanadium	16.2
Zinc	59

J-33 S FR-105	
Aluminum	2600
Arsenic	1.4
Barium	41.4
Beryllium	0.075 B
Chromium	2
Cobalt	1 B
Copper	2.4 B
Iron	2050
Lead	5.4
Manganese	207
Mercury	0.0076 B
Nickel	1.3 B
Vanadium	4.8 B
Zinc	11.1

J-37 S FR-119	
Aluminum	6190
Arsenic	2.2
Barium	381
Beryllium	0.27 B
Chromium	4.9
Cobalt	1.5 B
Copper	3.4
Iron	4810
Lead	6.7
Manganese	106
Mercury	0.0013 B
Nickel	2.5 B
Vanadium	13.2
Zinc	48.5

J-38 S FR-116	
Aluminum	9900
Arsenic	2.4
Barium	944
Beryllium	0.37 B
Chromium	6.4
Hex Chrom	1.2
Cobalt	2.3 B
Copper	4.2
Iron	6570
Lead	8
Manganese	110
Mercury	0.0054 B
Nickel	3.5 B
Vanadium	16
Zinc	29.8

J-39 S FR-113	
Aluminum	5110
Arsenic	1.5
Barium	63.5
Beryllium	0.12 B
Chromium	4.5
Cobalt	1.3 B
Copper	3.7
Iron	3560
Lead	6.9
Manganese	102
Mercury	0.019 B
Nickel	2.4 B
Vanadium	7.8
Zinc	25.9

J-40 S FR-109	
Aluminum	9850
Arsenic	2.8
Barium	177
Beryllium	0.34 B
Chromium	7.8
Cobalt	2.8 B
Copper	4.5
Iron	7510
Lead	20.9
Manganese	155
Mercury	0.0079 B
Nickel	4.2 B
Vanadium	15.8
Zinc	31.8

J-41 S FR-102	
Aluminum	4830
Arsenic	1.3
Barium	69.1
Beryllium	0.16 B
Cadmium	1.1
Chromium	3.7
Cobalt	1.2 B
Copper	4.8
Iron	3860
Lead	9.2
Manganese	65.6
Mercury	0.013 B
Nickel	2 B
Vanadium	7
Zinc	85.3

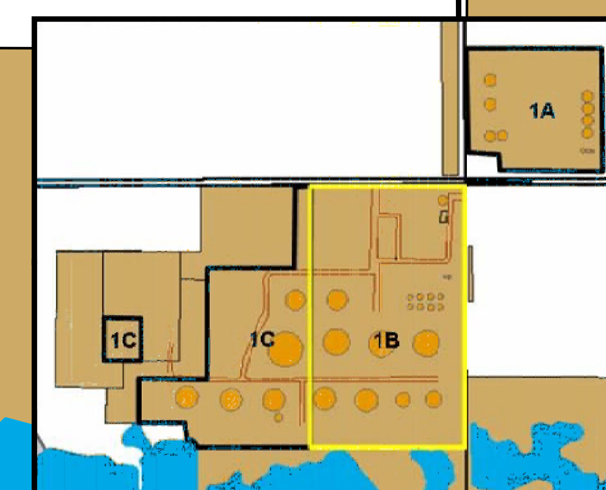
Legend

- Soil Sample Points
- Sediment Sample Points
- Roads
- Gravel/Dirt Road
- AOC-1B
- Refinery Tanks
- AOCs
- Wetland

N

0 100 200

Feet



Notes:

1. Results are posted in mg/kg
2. Qualifiers:
   U = Undetected at the sample detection limit (SDL)
   B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

- Exceeds Plant Limit
- Exceeds Median Background Limit
- Exceeds Earthworm and Plant Limits
- Exceeds Earthworm and Median Background Limits
- Exceeds Earthworm, Plant, and Median Background Limits
- SDL Exceeds Median Background Screening Level

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1B
Ecological
Metal Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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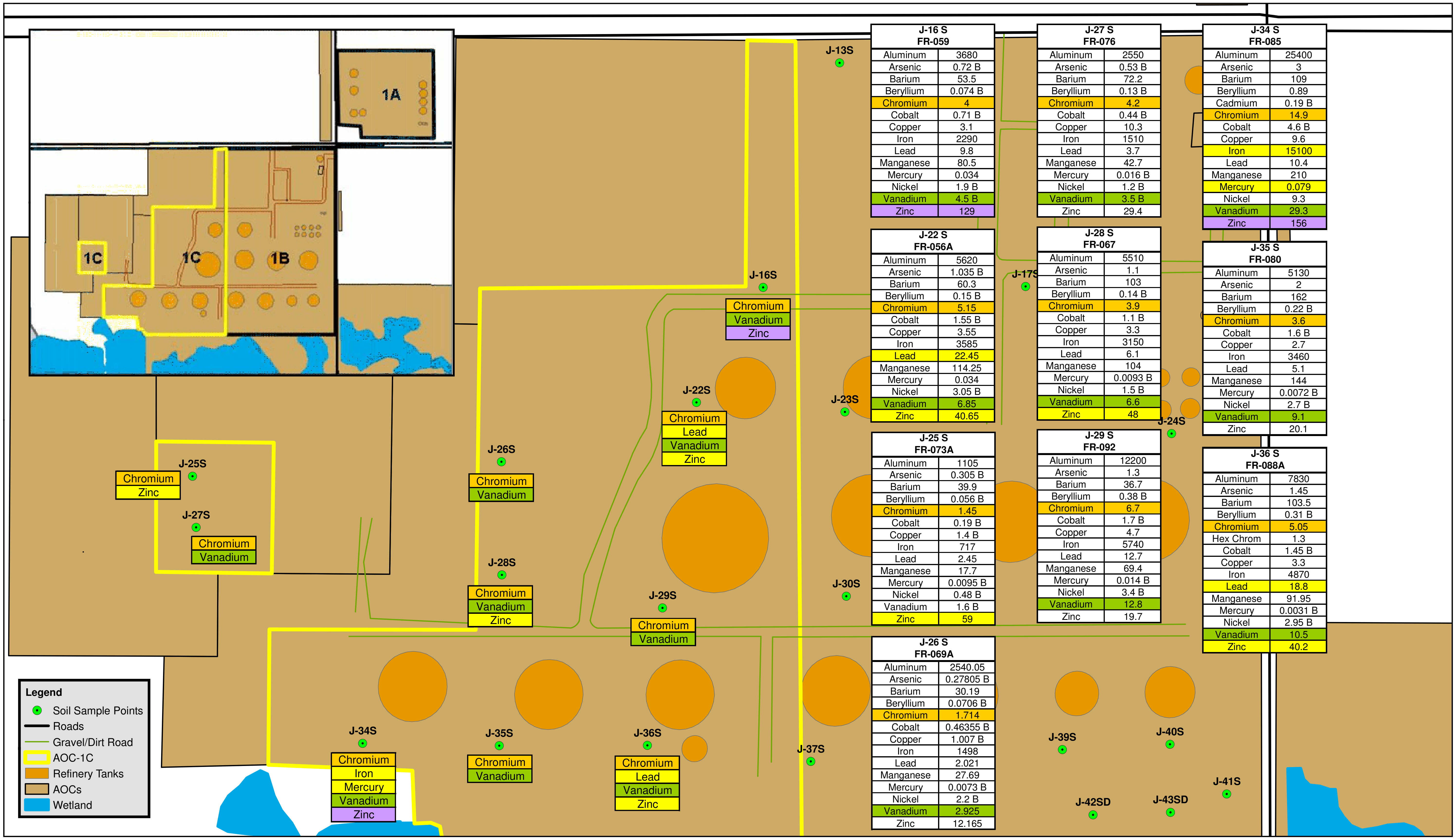
FIGURE
21B



J-16 S FR-059	
Aluminum	3680
Arsenic	0.72 B
Barium	53.5
Beryllium	0.074 B
Chromium	4
Cobalt	0.71 B
Copper	3.1
Iron	2290
Lead	9.8
Manganese	80.5
Mercury	0.034
Nickel	1.9 B
Vanadium	4.5 B
Zinc	129

J-27 S FR-076	
Aluminum	2550
Arsenic	0.53 B
Barium	72.2
Beryllium	0.13 B
Chromium	4.2
Cobalt	0.44 B
Copper	10.3
Iron	1510
Lead	3.7
Manganese	42.7
Mercury	0.016 B
Nickel	1.2 B
Vanadium	3.5 B
Zinc	29.4

J-34 S FR-085	
Aluminum	25400
Arsenic	3
Barium	109
Beryllium	0.89
Cadmium	0.19 B
Chromium	14.9
Cobalt	4.6 B
Copper	9.6
Iron	15100
Lead	10.4
Manganese	210
Mercury	0.079
Nickel	9.3
Vanadium	29.3
Zinc	156

J-22 S FR-056A	
Aluminum	5620
Arsenic	1.035 B
Barium	60.3
Beryllium	0.15 B
Chromium	5.15
Cobalt	1.55 B
Copper	3.55
Iron	3585
Lead	22.45
Manganese	114.25
Mercury	0.034
Nickel	3.05 B
Vanadium	6.85
Zinc	40.65

J-28 S FR-067	
Aluminum	5510
Arsenic	1.1
Barium	103
Beryllium	0.14 B
Chromium	3.9
Cobalt	1.1 B
Copper	3.3
Iron	3150
Lead	6.1
Manganese	104
Mercury	0.0093 B
Nickel	1.5 B
Vanadium	6.6
Zinc	48

J-35 S FR-080	
Aluminum	5130
Arsenic	2
Barium	162
Beryllium	0.22 B
Chromium	3.6
Cobalt	1.6 B
Copper	2.7
Iron	3460
Lead	5.1
Manganese	144
Mercury	0.0072 B
Nickel	2.7 B
Vanadium	9.1
Zinc	20.1

J-25 S FR-073A	
Aluminum	1105
Arsenic	0.305 B
Barium	39.9
Beryllium	0.056 B
Chromium	1.45
Cobalt	0.19 B
Copper	1.4 B
Iron	717
Lead	2.45
Manganese	17.7
Mercury	0.0095 B
Nickel	0.48 B
Vanadium	1.6 B
Zinc	59

J-29 S FR-092	
Aluminum	12200
Arsenic	1.3
Barium	36.7
Beryllium	0.38 B
Chromium	6.7
Cobalt	1.7 B
Copper	4.7
Iron	5740
Lead	12.7
Manganese	69.4
Mercury	0.014 B
Nickel	3.4 B
Vanadium	12.8
Zinc	19.7

J-36 S FR-088A	
Aluminum	7830
Arsenic	1.45
Barium	103.5
Beryllium	0.31 B
Chromium	5.05
Hex Chrom	1.3
Cobalt	1.45 B
Copper	3.3
Iron	4870
Lead	18.8
Manganese	91.95
Mercury	0.0031 B
Nickel	2.95 B
Vanadium	10.5
Zinc	40.2

J-26 S FR-069A	
Aluminum	2540.05
Arsenic	0.27805 B
Barium	30.19
Beryllium	0.0706 B
Chromium	1.714
Cobalt	0.46355 B
Copper	1.007 B
Iron	1498
Lead	2.021
Manganese	27.69
Mercury	0.0073 B
Nickel	2.2 B
Vanadium	2.925
Zinc	12.165

Notes:

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Exceeds Plant Limit
Exceeds Median Background Limit
Exceeds Earthworm and Plant Limits
Exceeds Earthworm and Median Background Limits

N

0 90 180
Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1C
Ecological
Metal Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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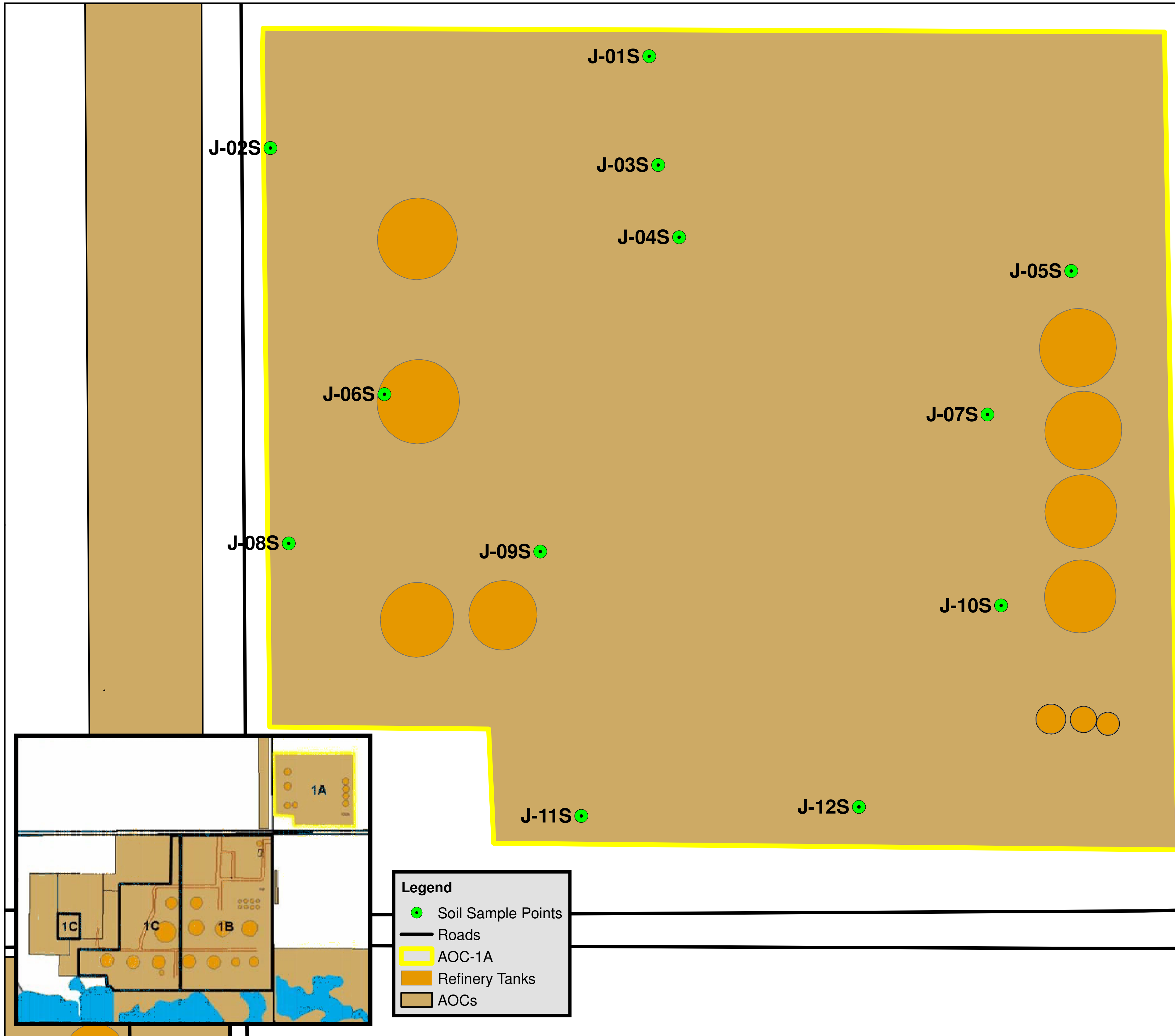
FIGURE
21C



J-01 S FR-013	
Methylene chloride	0.0038 J

J-02 S FR-016	
Methylene chloride	0.0034 J

J-03 S FR-009A	
Methylene chloride	0.00555 J

J-04 S FR-007	
Methylene chloride	0.0134

J-05 S FR-033	
Acetone	0.0963
Methylene chloride	0.0069 J

J-06 S FR-019A	
Methylene chloride	0.0048 J

J-07 S FR-030	
1,2,4-Trimethylbenzene	0.0025 J
Acetone	0.0099 J
Methylene chloride	0.0235
Toluene	0.0039 J
Xylene (total)	0.005 J

J-08 S FR-022	
Acetone	0.0099 J
Methylene chloride	0.004 J

J-09 S FR-025	
Methylene chloride	0.0043 J

J-10 S FR-027	
1,2,4-Trimethylbenzene	0.0015 J
Methylene chloride	0.0035 J

J-11 S FR-001	
Methylene chloride	0.0176

J-12 S FR-004	
Acetone	0.0401 J
Methylene chloride	0.0117

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

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0 50 100
Feet

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1A
Ecological
VOC Surface Soil Distribution Map

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INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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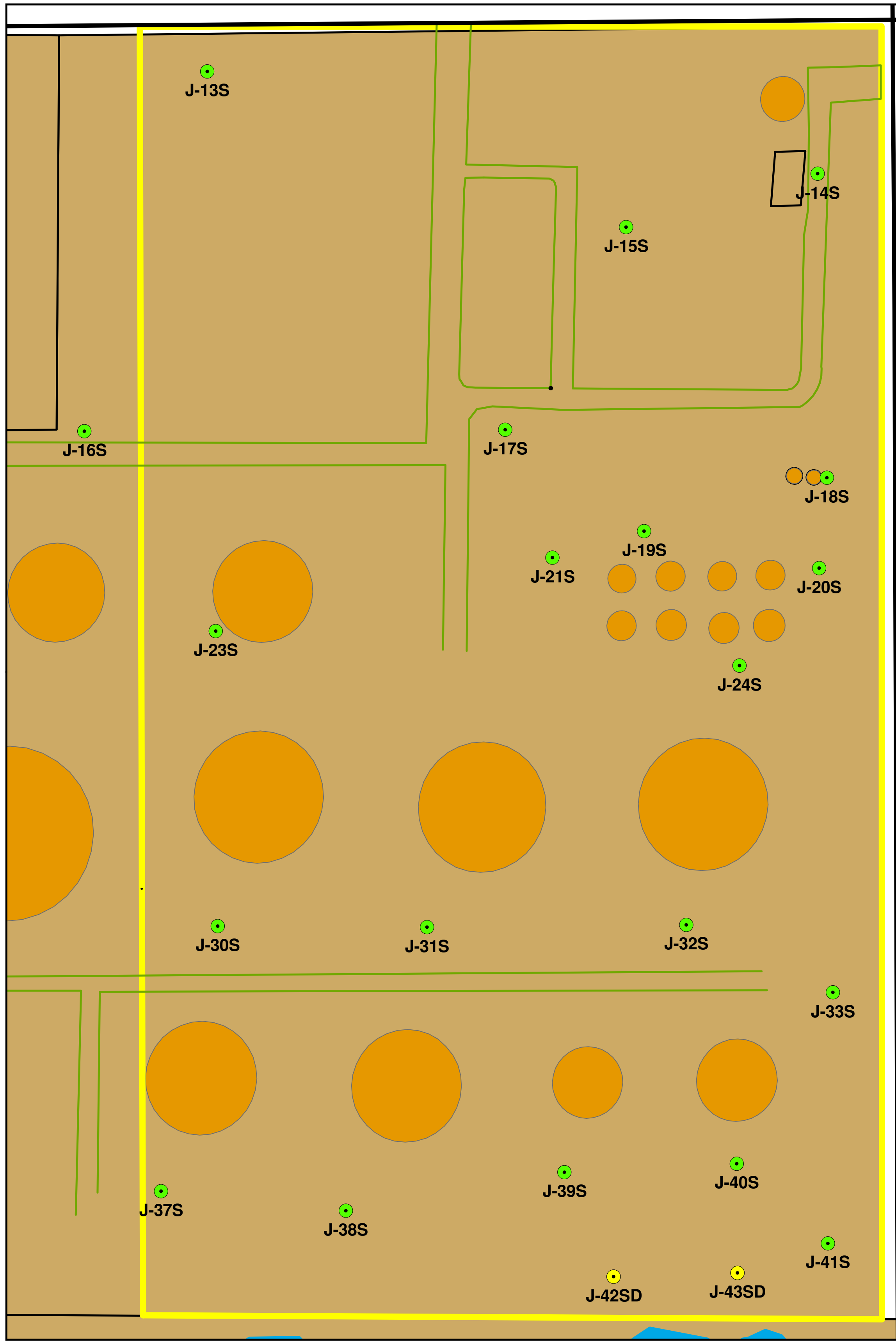
FIGURE
21D



J-14 S FR-061	
Acetone	0.0121 J

J-15 S FR-035	
Methylene chloride	0.0041 J

J-17 S FR-046	
1,2,4-Trimethylbenzene	0.002 J
Methylene chloride	0.0048 J
Xylene (total)	0.0062 J

J-18 S FR-050	
1,3,5-Trimethylbenzene	0.0018 J
Xylene (total)	0.0047 J

J-19 S FR-039A	
Isopropylbenzene	0.02265
Methylene chloride	0.004 J
p-Isopropyltoluene	0.0015 J

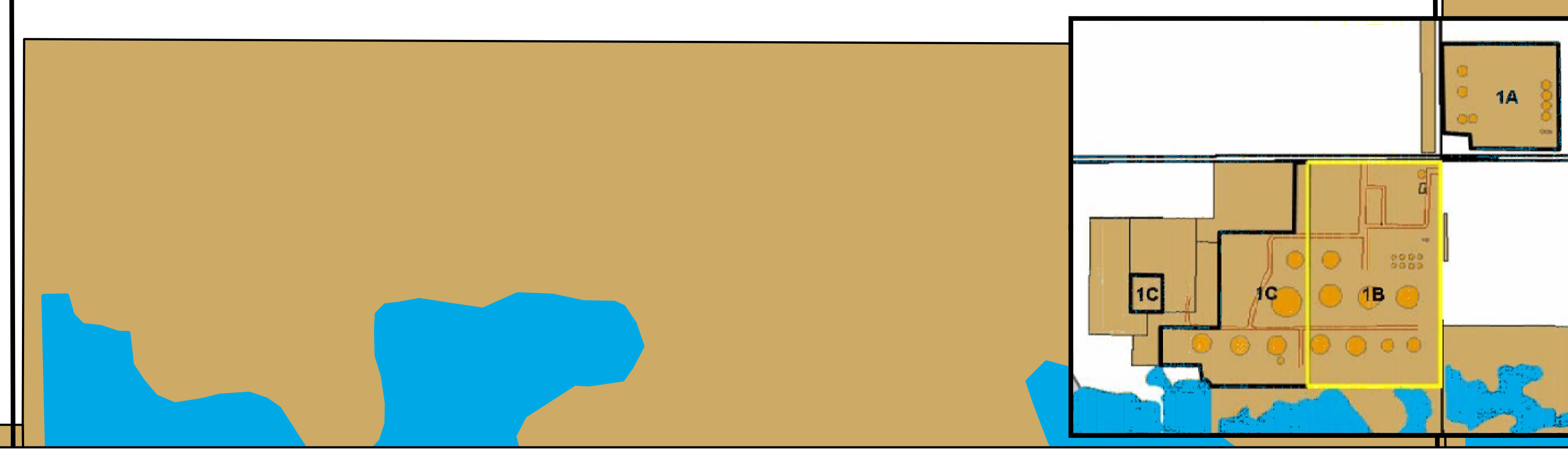
J-20 S FR-044	
1,2,4-Trimethylbenzene	0.0032 J
1,3,5-Trimethylbenzene	0.0023 J
Ethylbenzene	0.002 J
Isopropylbenzene	0.0014 J
Methylene chloride	0.0114
n-Propylbenzene	0.0014 J
Toluene	0.0044 J
Xylene (total)	0.0077 J

J-21 S FR-037	
Methylene chloride	0.0096 J

J-23 S FR-054	
Toluene	0.0014 J

J-31 S FR-099A	
1,2,4-Trimethylbenzene	0.0015 J
Toluene	0.0015 J

Legend
- Soil Sample Points
- Sediment Sample Points
- Roads
- Gravel/Dirt Road
- AOC-1B
- Refinery Tanks
- AOCs
- Wetland



Notes:

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N

0 100 200
Feet

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CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1B
Ecological
VOC Surface Soil Distribution Map

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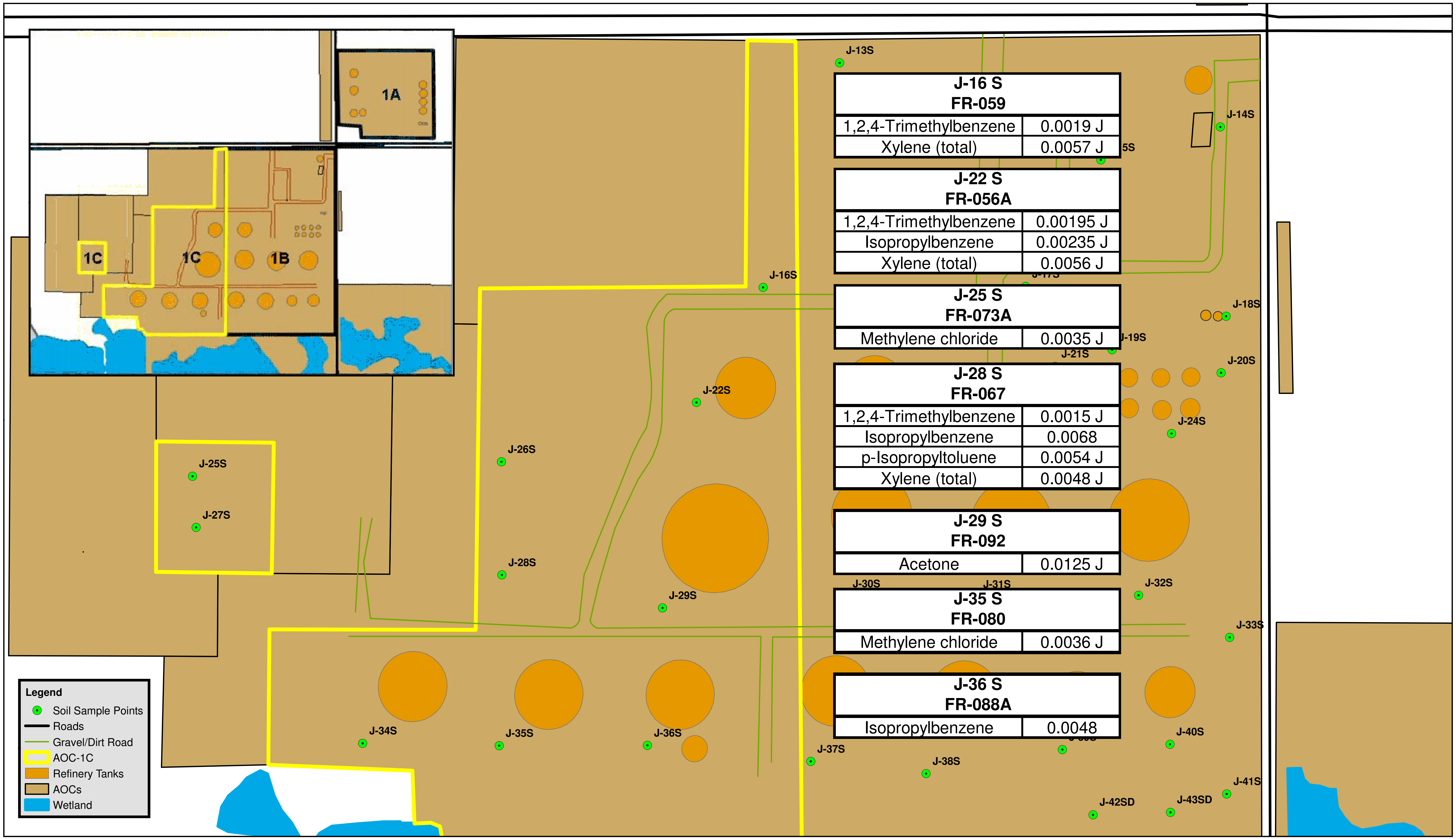
FIGURE
21E



Notes:

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2. Qualifiers:

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N

0 100 200
Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
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CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1C
Ecological
VOC Surface Soil Distribution Map

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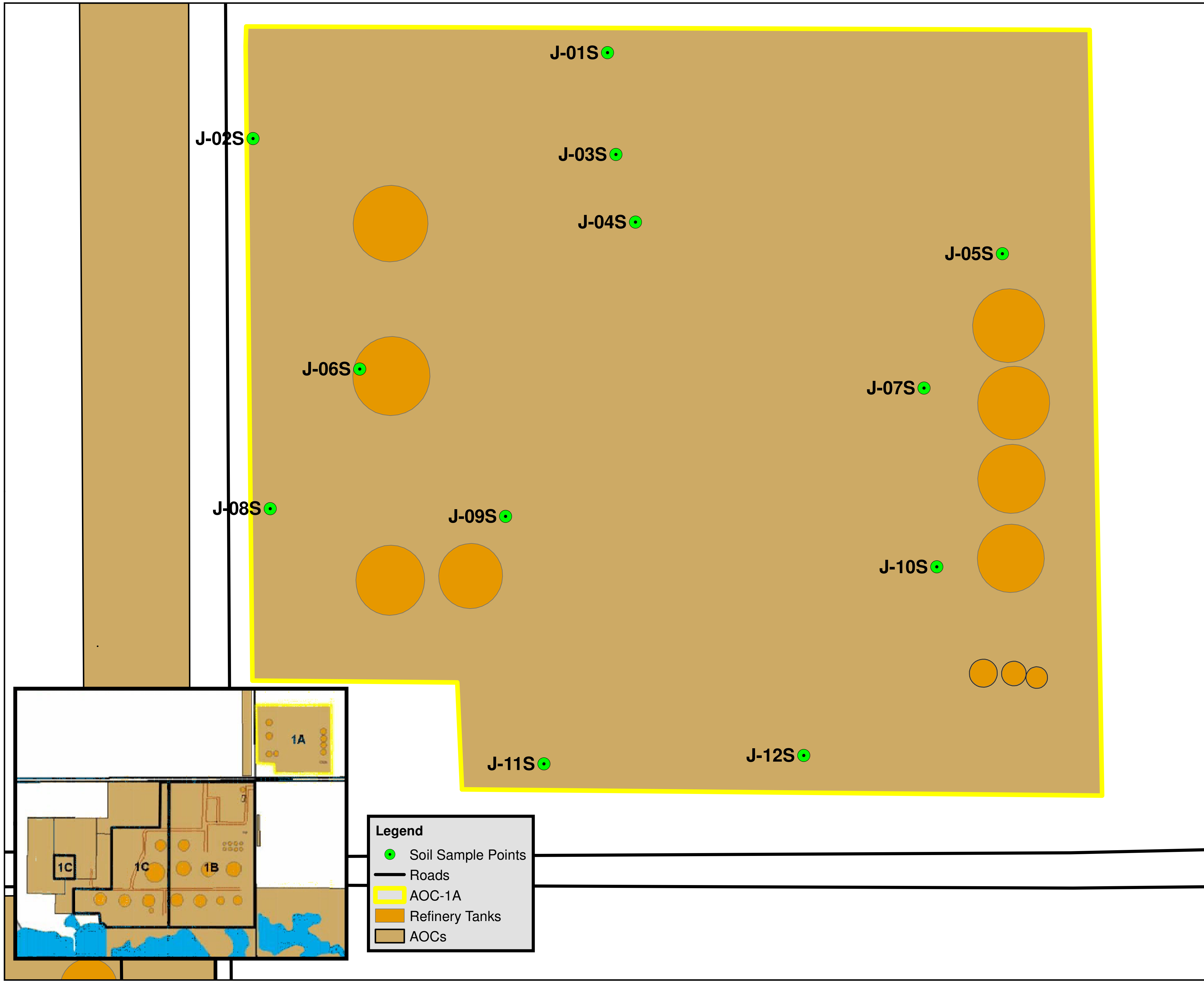
FIGURE
21F



J-03 S FR-009A	
6-Methyl Chrysene	3.93
Anthracene	3.245
Benzo(a)anthracene	2.07
bis(2-Ethylhexyl)phthalate	0.3395 J
Carbazole	0.325 J
Chrysene	18.905
Fluorene	0.25 J
Phenanthrene	1.1935
Pyrene	0.3825 J

J-04 S FR-007	
6-Methyl Chrysene	17.3
Anthracene	5.33
Benzo(a)anthracene	3.97
Benzo(a)pyrene	0.766 J
Chrysene	41.2
Phenanthrene	2.06 J

J-09 S FR-025	
Anthracene	0.107 J
Benzo(a)anthracene	0.648
Benzo(a)pyrene	0.775
Benzo(b)fluoranthene	1.03
Benzo(g,h,i)perylene	0.629
Benzo(k)fluoranthene	0.326
Chrysene	0.773
Dibenzo(a,h)anthracene	0.281
Fluoranthene	1.42
Indeno(1,2,3-cd)pyrene	0.813
Phenanthrene	0.679
Pyrene	1.58

J-12 S FR-004	
Benzo(a)anthracene	0.121 J
Benzo(a)pyrene	0.172 J
Benzo(b)fluoranthene	0.218
Benzo(g,h,i)perylene	0.295
Chrysene	0.163 J
Fluoranthene	0.192
Indeno(1,2,3-cd)pyrene	0.192
Pyrene	0.237

Notes:

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DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09	
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CHECKED BY: S. HALASZ		
APPROVED BY:		

AOC-1A Ecological SVOC Surface Soil Distribution Map

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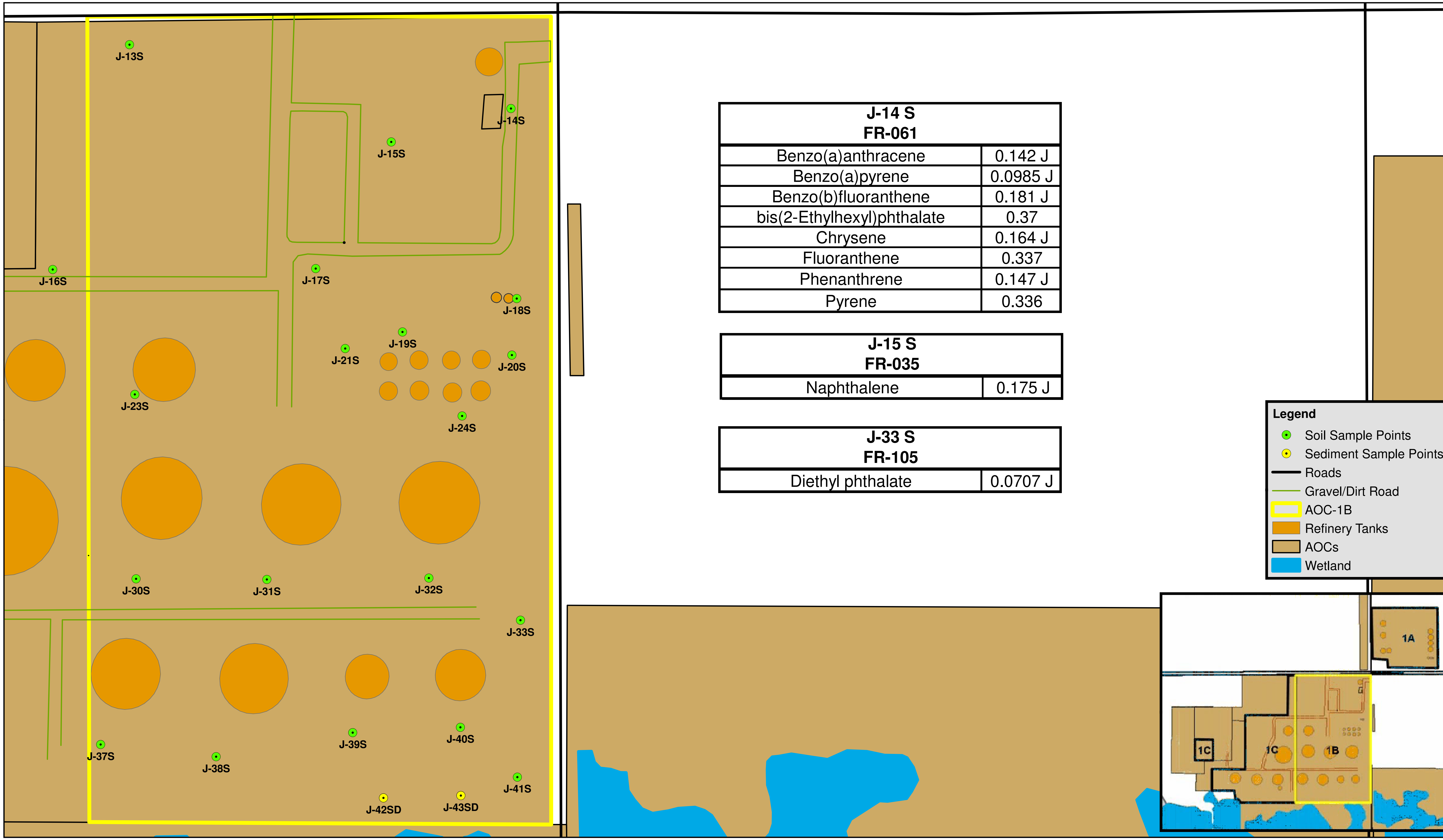
FIGURE
21G



J-14 S FR-061	
Benzo(a)anthracene	0.142 J
Benzo(a)pyrene	0.0985 J
Benzo(b)fluoranthene	0.181 J
bis(2-Ethylhexyl)phthalate	0.37
Chrysene	0.164 J
Fluoranthene	0.337
Phenanthrene	0.147 J
Pyrene	0.336

J-15 S FR-035	
Naphthalene	0.175 J

J-33 S FR-105	
Diethyl phthalate	0.0707 J

Legend

- Soil Sample Points
- Sediment Sample Points
- Roads
- Gravel/Dirt Road
- AOC-1B
- Refinery Tanks
- AOCs
- Wetland

Notes:

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N

0 100 200

Feet

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APPROVED BY:	

AOC-1B
Ecological
SVOC Surface Soil Distribution Map

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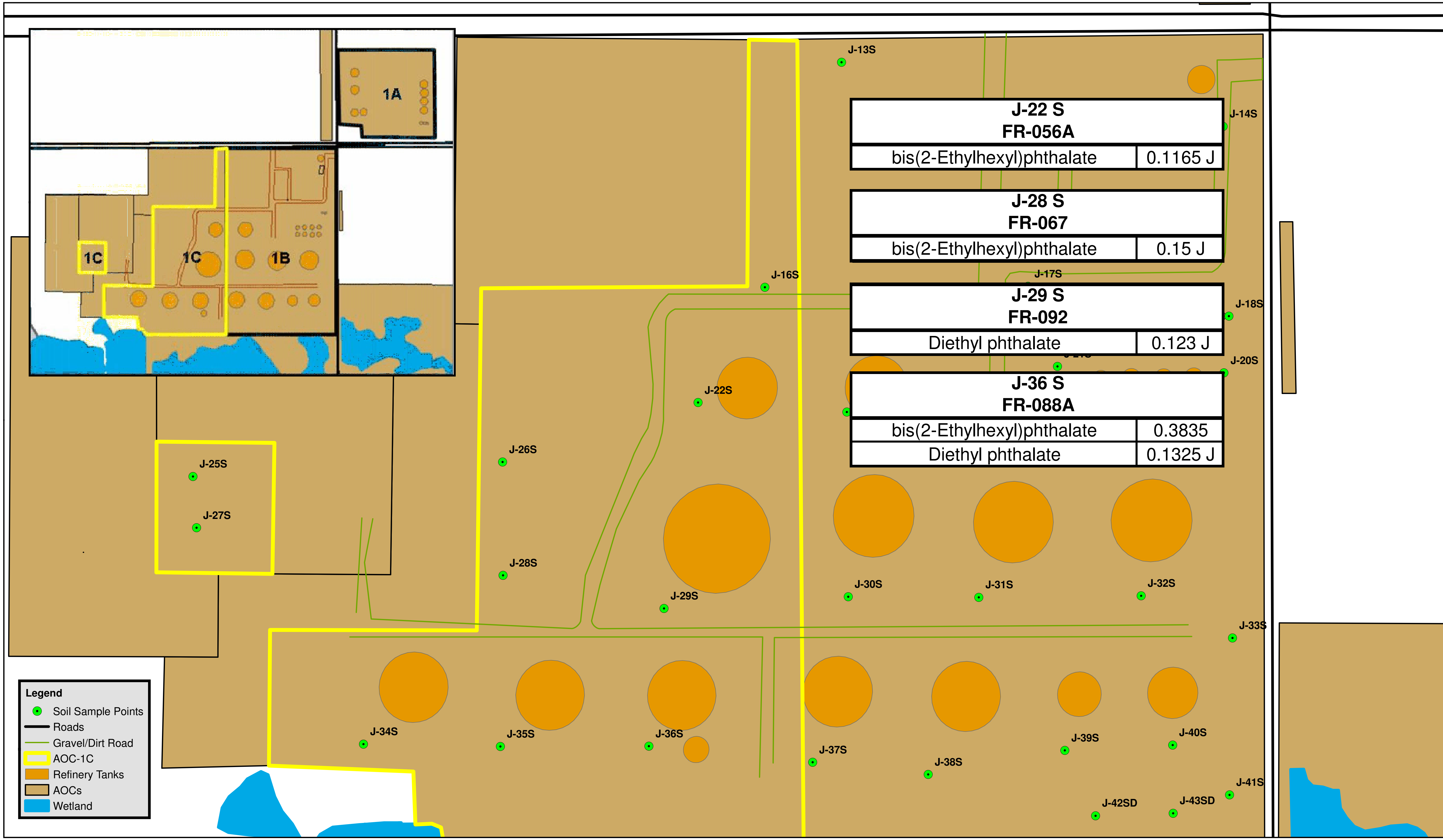
FIGURE
21H



Notes:

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2. Qualifiers:

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N

0 100 200

Feet

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CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1C
Ecological
SVOC Surface Soil Distribution Map

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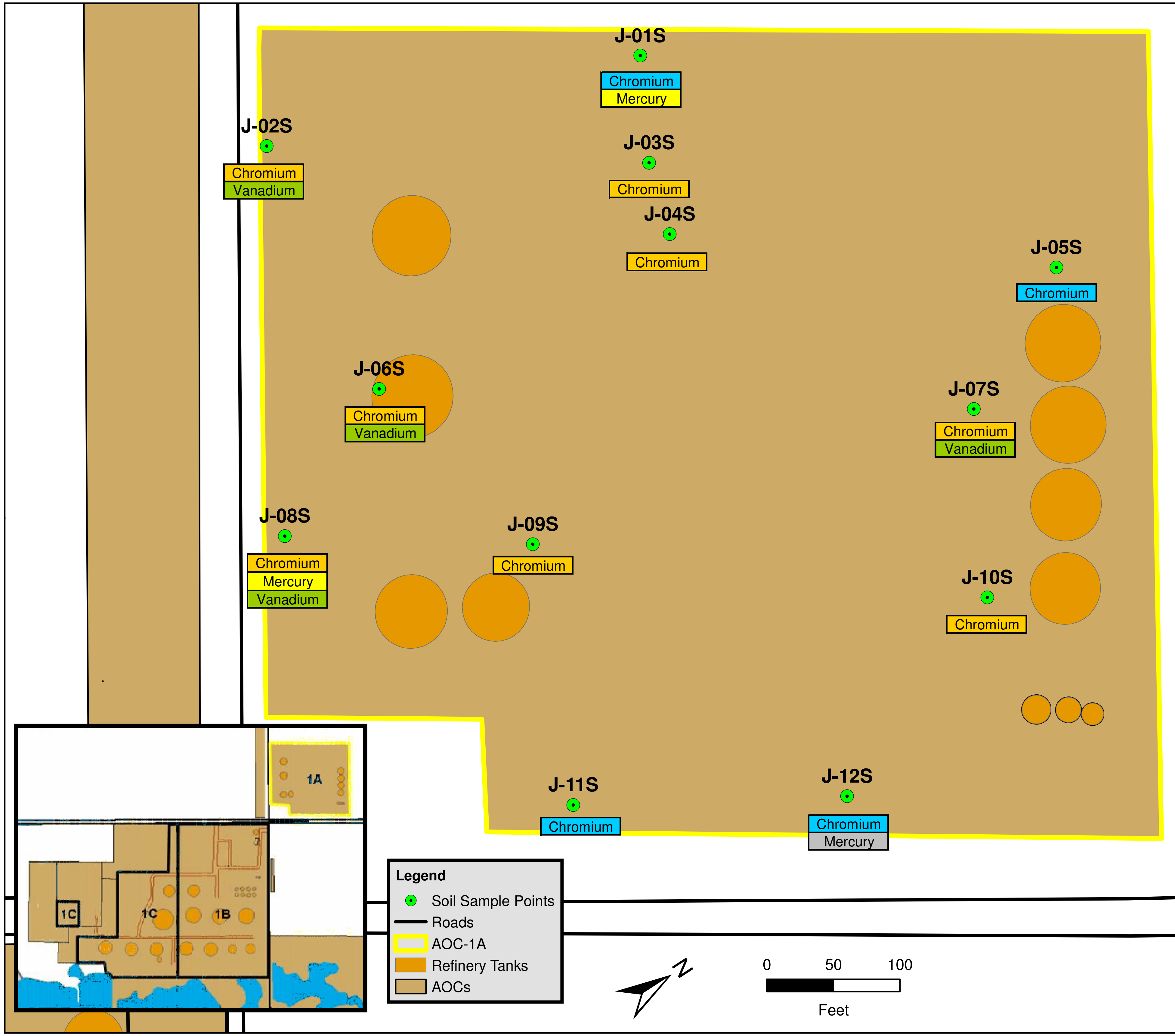
FIGURE

21I



J-01 S FR-014	
Aluminum	1200
Barium	7.7 B
Chromium	0.63 B
Copper	0.59 B
Iron	235
Lead	1.9
Manganese	4.4
Mercury	0.055
Nickel	0.18 B
Vanadium	0.97 B
Zinc	1.6 B

J-02 S FR-017	
Aluminum	7690
Arsenic	0.34 B
Barium	31.1
Beryllium	0.15 B
Chromium	3.9
Cobalt	0.44 B
Copper	1.5 B
Iron	1900
Lead	3.8
Manganese	12.9
Mercury	0.019
Nickel	1.8 B
Vanadium	5
Zinc	7.3

J-03 S FR-011	
Aluminum	2250
Barium	11.8 B
Beryllium	0.035 B
Chromium	1.2
Copper	0.58 B
Iron	494
Lead	2.4
Manganese	5.1
Mercury	0.0051 B
Nickel	0.46 B
Vanadium	1.7 B
Zinc	2.2

J-04 S FR-008	
Aluminum	747
Barium	8.6 B
Chromium	2.1
Copper	0.79 B
Iron	363
Lead	2.3
Manganese	6.2
Nickel	0.32 B
Vanadium	1 B
Zinc	2.9

J-05 S FR-034	
Aluminum	959
Barium	8.5 B
Beryllium	0.042 B
Chromium	0.8
Copper	0.44 B
Iron	624
Lead	2.7
Manganese	4.6
Mercury	0.0021 B
Nickel	0.28 B
Vanadium	0.77 B
Zinc	3.6

J-06 S FR-021	
Aluminum	6880
Arsenic	0.23 B
Barium	23.1
Beryllium	0.13 B
Chromium	3.7
Cobalt	0.35 B
Copper	1.3 B
Iron	2000
Lead	3.2
Manganese	9.9
Mercury	0.033
Nickel	1.3 B
Vanadium	5.3
Zinc	7

J-07 S FR-031	
Aluminum	11400
Arsenic	0.47 B
Barium	52.4
Beryllium	0.28 B
Chromium	4.3
Cobalt	0.56 B
Copper	1.6 B
Iron	2680
Lead	4.3
Manganese	10.8
Mercury	0.012 B
Nickel	1.8 B
Vanadium	7.1
Zinc	10.3

J-08 S FR-023	
Aluminum	10900
Arsenic	0.29 B
Barium	29.3
Beryllium	0.25 B
Chromium	5.2
Cobalt	0.72 B
Copper	2
Iron	4410
Lead	4.1
Manganese	13.9
Mercury	0.048
Nickel	1.8 B
Vanadium	5.7
Zinc	15

J-09 S FR-026	
Aluminum	858
Barium	5.4 B
Beryllium	0.035 B
Chromium	1.8
Copper	0.48 B
Iron	341
Lead	1.5
Manganese	4.1
Nickel	0.22 B
Vanadium	0.95 B
Zinc	1.6 B

J-10 S FR-028	
Aluminum	1090
Barium	6.7 B
Beryllium	0.047 B
Chromium	1
Copper	0.35 B
Iron	258
Lead	1.7
Manganese	3.1
Nickel	0.21 B
Vanadium	0.83 B
Zinc	3.1

J-11 S FR-002	
Aluminum	1110
Arsenic	0.26 B
Barium	10.2 B
Beryllium	0.1 B
Chromium	0.98 B
Copper	0.49 B
Iron	224
Lead	2.3
Manganese	3.5
Mercury	0.0017 B
Nickel	0.26 B
Vanadium	0.89 B
Zinc	1.5 B

J-12 S FR-005	
Aluminum	748
Barium	4.2 B
Chromium	0.58 B
Copper	0.47 B
Iron	174
Lead	1.3
Manganese	2.7
Mercury	0.59
Selenium	0.22 B
Vanadium	0.65 B
Zinc	1.5 B

Notes:

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2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

- Exceeds Earthworm Limit
- Exceeds Plant Limit
- Exceeds Median Background Limit
- Exceeds Earthworm and Plant Limits
- Exceeds Earthworm, Plant, and Median Background Limits

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1A Ecological Metal Subsurface Soil Distribution Map

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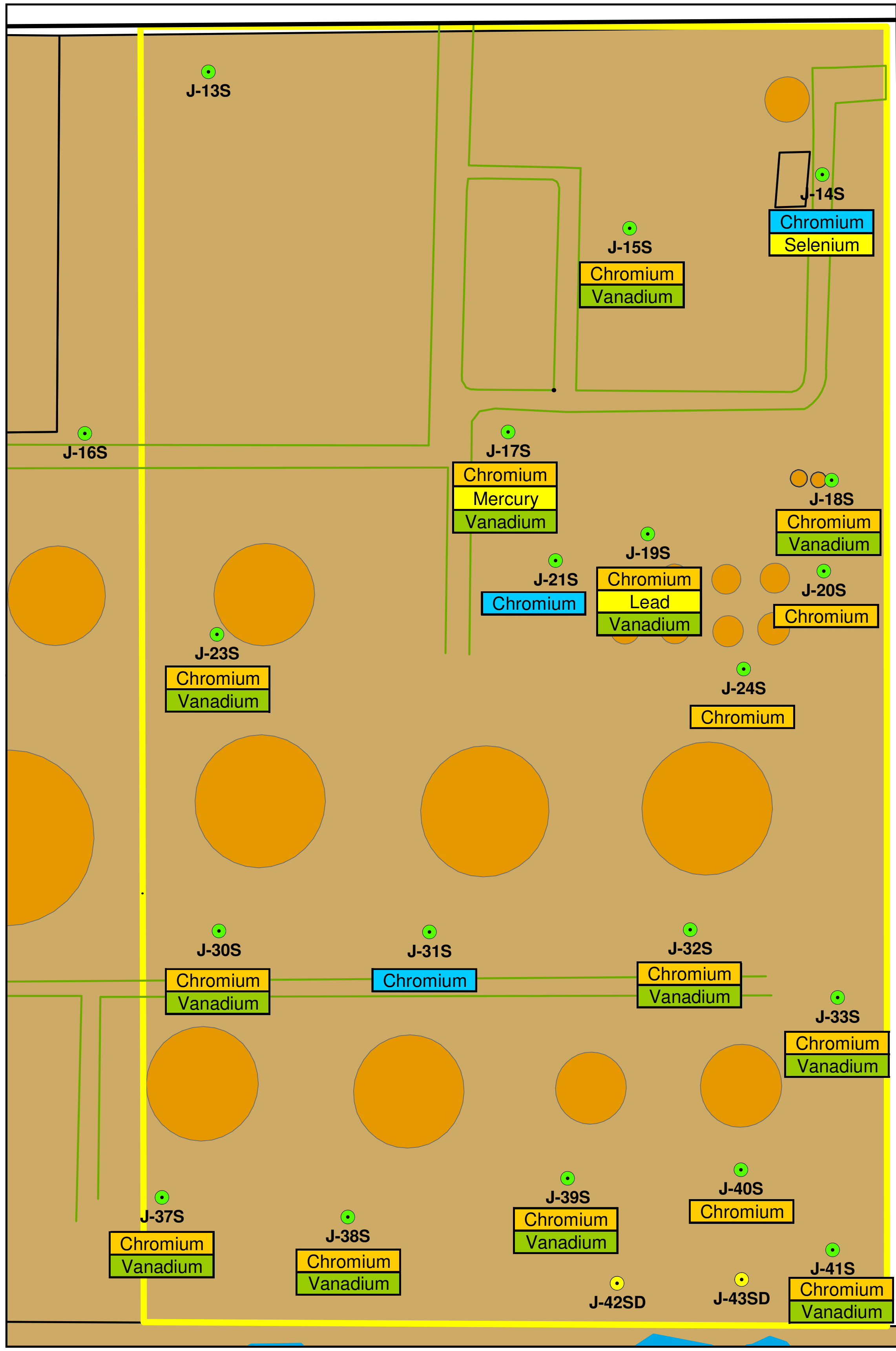
FIGURE
22A



J-14 S FR-062	
Aluminum	917
Barium	7.4 B
Chromium	0.6 B
Hex Chrom	1.3 B
Copper	0.39 B
Iron	270
Lead	1.8
Manganese	5.5
Selenium	0.36 B
Vanadium	1.3 B
Zinc	2.1 B

J-15 S FR-036	
Aluminum	5880
Arsenic	0.38 B
Barium	26.5
Beryllium	0.32 B
Chromium	3.4
Cobalt	0.58 B
Copper	3.8
Iron	2220
Lead	3.5
Manganese	11.9
Mercury	0.013 B
Nickel	1.5 B
Vanadium	4.4 B
Zinc	8.1

J-17 S FR-047	
Aluminum	1130
Arsenic	0.41 B
Barium	11.4 B
Chromium	2.4
Cobalt	0.24 B
Copper	0.45 B
Iron	1230
Lead	2.3
Manganese	9.9
Mercury	0.055
Nickel	0.29 B
Selenium	0.31 U
Vanadium	2.1 B
Zinc	2.3 B

J-18 S FR-051	
Aluminum	3510
Arsenic	0.44 B
Barium	21.5 B
Beryllium	0.086 B
Chromium	3.2
Hex Chrom	1.6 B
Cobalt	0.25 B
Copper	0.89 B
Iron	1270
Lead	4.2
Manganese	10.1
Mercury	0.0048 B
Nickel	0.36 B
Vanadium	3.6 B
Zinc	4.4

J-19 S FR-041	
Aluminum	1760
Arsenic	1.7
Barium	98.7
Beryllium	0.13 B
Chromium	15
Cobalt	0.69 B
Copper	5.9
Iron	3080
Lead	26
Manganese	19.7
Mercury	0.0065 B
Nickel	5.9
Vanadium	3.2 B
Zinc	18.9

J-20 S FR-045	
Aluminum	915
Barium	11.5 B
Chromium	2.5
Copper	0.62 B
Iron	548
Lead	2.1
Manganese	7.5
Nickel	0.22 B
Vanadium	1.8 B
Zinc	3.2

J-21 S FR-038	
Aluminum	648
Barium	4.6 B
Beryllium	0.054 B
Chromium	0.59 B
Hex Chrom	1.2 B
Copper	0.39 B
Iron	381
Lead	1.5
Manganese	4.5
Vanadium	1.1 B
Zinc	4.4

J-23 S FR-055	
Aluminum	4180
Arsenic	1.4
Barium	41.8
Beryllium	0.1 B
Chromium	3.5
Cobalt	1.2 B
Copper	2.4 B
Iron	2590
Lead	3.6
Manganese	130
Mercury	0.0077 B
Nickel	2.6 B
Vanadium	6.7
Zinc	11

J-24 S FR-043	
Aluminum	790
Arsenic	0.3 B
Barium	12 B
Beryllium	0.064 B
Chromium	1.2
Copper	0.9 B
Iron	529
Lead	3.1
Manganese	9.1
Mercury	0.012 B
Nickel	0.23 B
Vanadium	1.2 B
Zinc	5.7

J-30 S FR-095	
Aluminum	1770
Arsenic	0.54 B
Barium	25.1
Beryllium	0.11 B
Chromium	2.2
Cobalt	0.56 B
Copper	1.1 B
Iron	1130
Lead	2.7
Manganese	69.5
Mercury	0.0043 B
Nickel	1 B
Vanadium	2.4 B
Zinc	7

J-31 S FR-101	
Aluminum	1390
Arsenic	0.23 B
Barium	13.5 B
Beryllium	0.023 B
Chromium	0.76 B
Cobalt	0.31 B
Copper	1.2 B
Iron	693
Lead	1.7
Manganese	9
Mercury	0.0026 B
Nickel	0.26 B
Vanadium	1.7 B
Zinc	8.3

J-32 S FR-097	
Aluminum	2460
Arsenic	1.1
Barium	39.6
Beryllium	0.12 B
Chromium	2.9
Cobalt	0.55 B
Copper	1.1 B
Iron	1790
Lead	2.7
Manganese	29
Nickel	1.3 B
Vanadium	3.7 B
Zinc	6.4

J-33 S FR-106	
Aluminum	1240
Arsenic	0.81 B
Barium	36.2
Beryllium	0.044 B
Chromium	1.9
Cobalt	0.84 B
Copper	1 B
Iron	1400
Lead	5.9
Manganese	73
Mercury	0.0048 B
Nickel	0.36 B
Vanadium	2 B
Zinc	2.8

J-37 S FR-120	
Aluminum	8450
Arsenic	2.1
Barium	97.8
Beryllium	0.29 B
Chromium	8.8
Cobalt	1.5 B
Copper	4.4
Iron	5250
Lead	6
Manganese	112
Nickel	2.9 B
Vanadium	12.1
Zinc	16.6

J-38 S FR-117	
Aluminum	3310
Arsenic	2.2
Barium	25
Beryllium	0.11 B
Chromium	2.5
Cobalt	0.58 B
Copper	1.9 B
Iron	1930
Lead	5.7
Manganese	153
Mercury	0.0013 B
Nickel	1.4 B
Vanadium	5.8
Zinc	7.2

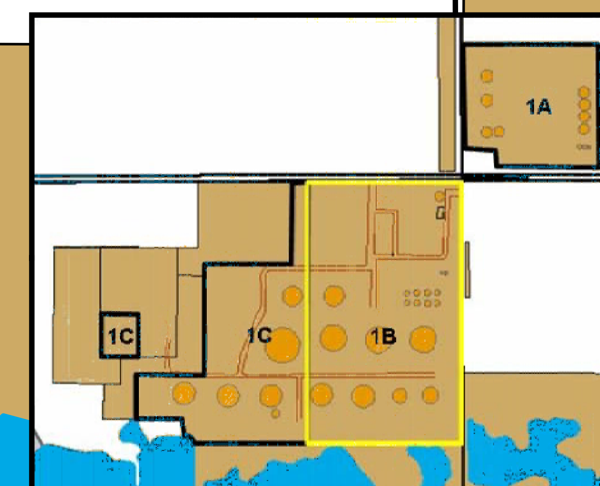
J-39 S FR-114	
Aluminum	1160
Arsenic	0.7 B
Barium	16.3 B
Beryllium	0.041 B
Chromium	1.4
Cobalt	0.26 B
Copper	0.61 B
Iron	954
Lead	1.6
Manganese	76.3
Mercury	0.014 B
Nickel	0.39 B
Vanadium	2.4 B
Zinc	2.3

J-40 S FR-110A	
Aluminum	1495
Arsenic	0.62 B
Barium	59.65
Beryllium	0.0445 B
Chromium	2.3
Cobalt	0.715 B
Copper	0.725 B
Iron	1350
Lead	2.15
Manganese	70.05
Mercury	0.0046 B
Nickel	0.66 B
Vanadium	1.95 B
Zinc	3.1

J-41 S FR-103	
Aluminum	2480
Arsenic	1.7
Barium	26.4
Beryllium	0.067 B
Chromium	2.2
Cobalt	0.78 B
Copper	1.9 B
Iron	1780
Lead	6.3
Manganese	134
Mercury	0.0053 B
Nickel	0.99 B
Vanadium	4.3 B
Zinc	6.7

Legend

- Soil Sample Points
- Sediment Sample Points
- Roads
- Gravel/Dirt Road
- AOC-1B
- Refinery Tanks
- AOCs
- Wetland



Notes:

1. Results are posted in mg/kg
2. Qualifiers:
   U = Undetected at the sample detection limit (SDL)
   B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

- Exceeds Earthworm Limit
- Exceeds Plant Limit
- Exceeds Median Background Limit
- Exceeds Earthworm and Plant Limits
- SDL Exceeds Median Background Screening Level

0 100 200

Feet

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1B Ecological Metal Subsurface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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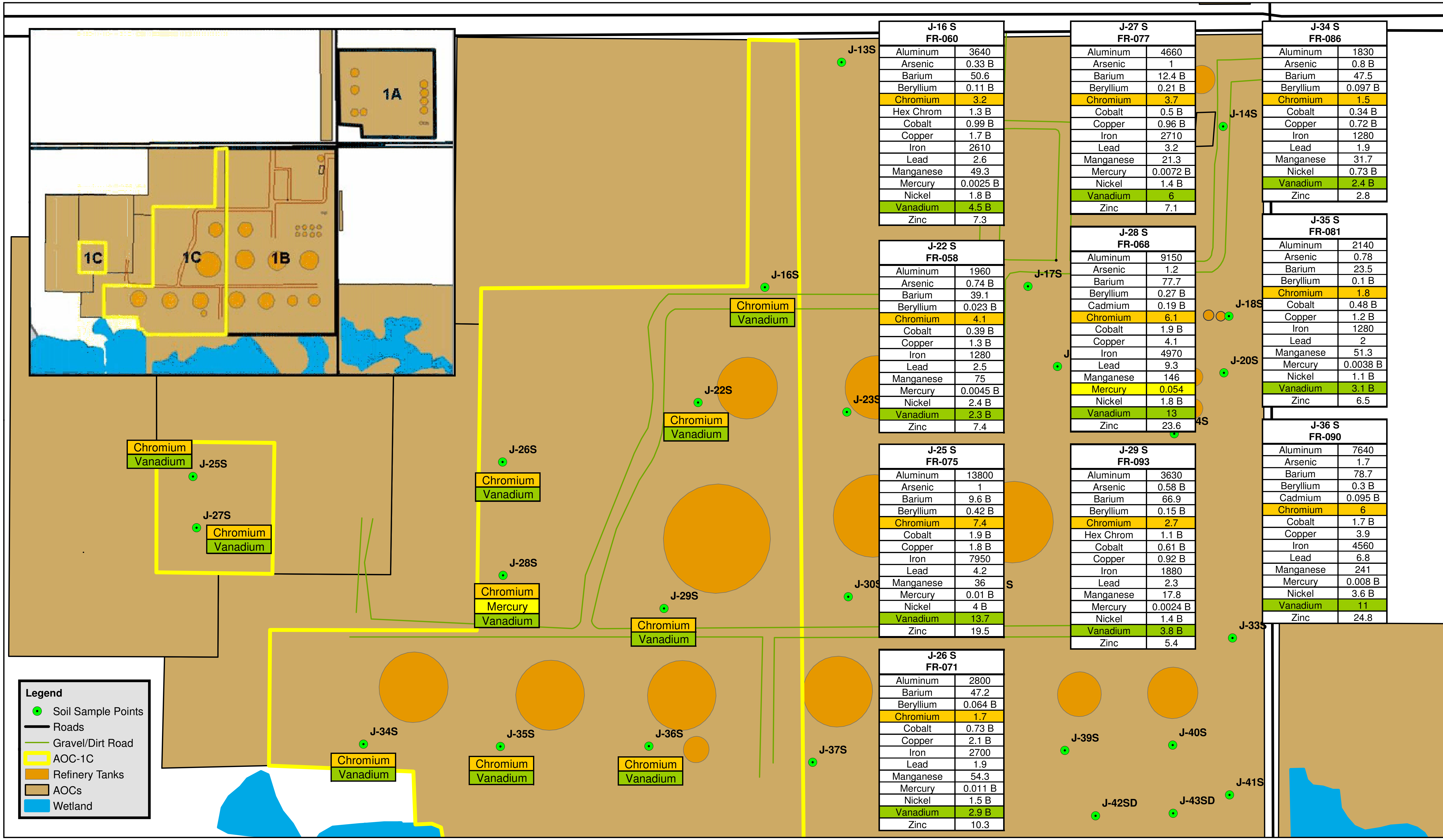
FIGURE

22B



J-16 S FR-060	
Aluminum	3640
Arsenic	0.33 B
Barium	50.6
Beryllium	0.11 B
Chromium	3.2
Hex Chrom	1.3 B
Cobalt	0.99 B
Copper	1.7 B
Iron	2610
Lead	2.6
Manganese	49.3
Mercury	0.0025 B
Nickel	1.8 B
Vanadium	4.5 B
Zinc	7.3

J-27 S FR-077	
Aluminum	4660
Arsenic	1
Barium	12.4 B
Beryllium	0.21 B
Chromium	3.7
Cobalt	0.5 B
Copper	0.96 B
Iron	2710
Lead	3.2
Manganese	21.3
Mercury	0.0072 B
Nickel	1.4 B
Vanadium	6
Zinc	7.1

J-34 S FR-086	
Aluminum	1830
Arsenic	0.8 B
Barium	47.5
Beryllium	0.097 B
Chromium	1.5
Cobalt	0.34 B
Copper	0.72 B
Iron	1280
Lead	1.9
Manganese	31.7
Nickel	0.73 B
Vanadium	2.4 B
Zinc	2.8

J-22 S FR-058	
Aluminum	1960
Arsenic	0.74 B
Barium	39.1
Beryllium	0.023 B
Chromium	4.1
Cobalt	0.39 B
Copper	1.3 B
Iron	1280
Lead	2.5
Manganese	75
Mercury	0.0045 B
Nickel	2.4 B
Vanadium	2.3 B
Zinc	7.4

J-28 S FR-068	
Aluminum	9150
Arsenic	1.2
Barium	77.7
Beryllium	0.27 B
Cadmium	0.19 B
Chromium	6.1
Cobalt	1.9 B
Copper	4.1
Iron	4970
Lead	9.3
Manganese	146
Mercury	0.054
Nickel	1.8 B
Vanadium	13
Zinc	23.6

J-35 S FR-081	
Aluminum	2140
Arsenic	0.78
Barium	23.5
Beryllium	0.1 B
Chromium	1.8
Cobalt	0.48 B
Copper	1.2 B
Iron	1280
Lead	2
Manganese	51.3
Mercury	0.0038 B
Nickel	1.1 B
Vanadium	3.1 B
Zinc	6.5

J-25 S FR-075	
Aluminum	13800
Arsenic	1
Barium	9.6 B
Beryllium	0.42 B
Chromium	7.4
Cobalt	1.9 B
Copper	1.8 B
Iron	7950
Lead	4.2
Manganese	36
Mercury	0.01 B
Nickel	4 B
Vanadium	13.7
Zinc	19.5

J-29 S FR-093	
Aluminum	3630
Arsenic	0.58 B
Barium	66.9
Beryllium	0.15 B
Chromium	2.7
Hex Chrom	1.1 B
Cobalt	0.61 B
Copper	0.92 B
Iron	1880
Lead	2.3
Manganese	17.8
Mercury	0.0024 B
Nickel	1.4 B
Vanadium	3.8 B
Zinc	5.4

J-36 S FR-090	
Aluminum	7640
Arsenic	1.7
Barium	78.7
Beryllium	0.3 B
Cadmium	0.095 B
Chromium	6
Cobalt	1.7 B
Copper	3.9
Iron	4560
Lead	6.8
Manganese	241
Mercury	0.008 B
Nickel	3.6 B
Vanadium	11
Zinc	24.8

J-26 S FR-071	
Aluminum	2800
Barium	47.2
Beryllium	0.064 B
Chromium	1.7
Cobalt	0.73 B
Copper	2.1 B
Iron	2700
Lead	1.9
Manganese	54.3
Mercury	0.011 B
Nickel	1.5 B
Vanadium	2.9 B
Zinc	10.3

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

   B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds Plant Limit
Exceeds Median Background Limit
Exceeds Earthworm and Plant Limits

N

0 90 180

Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1C
Ecological
Metal Subsurface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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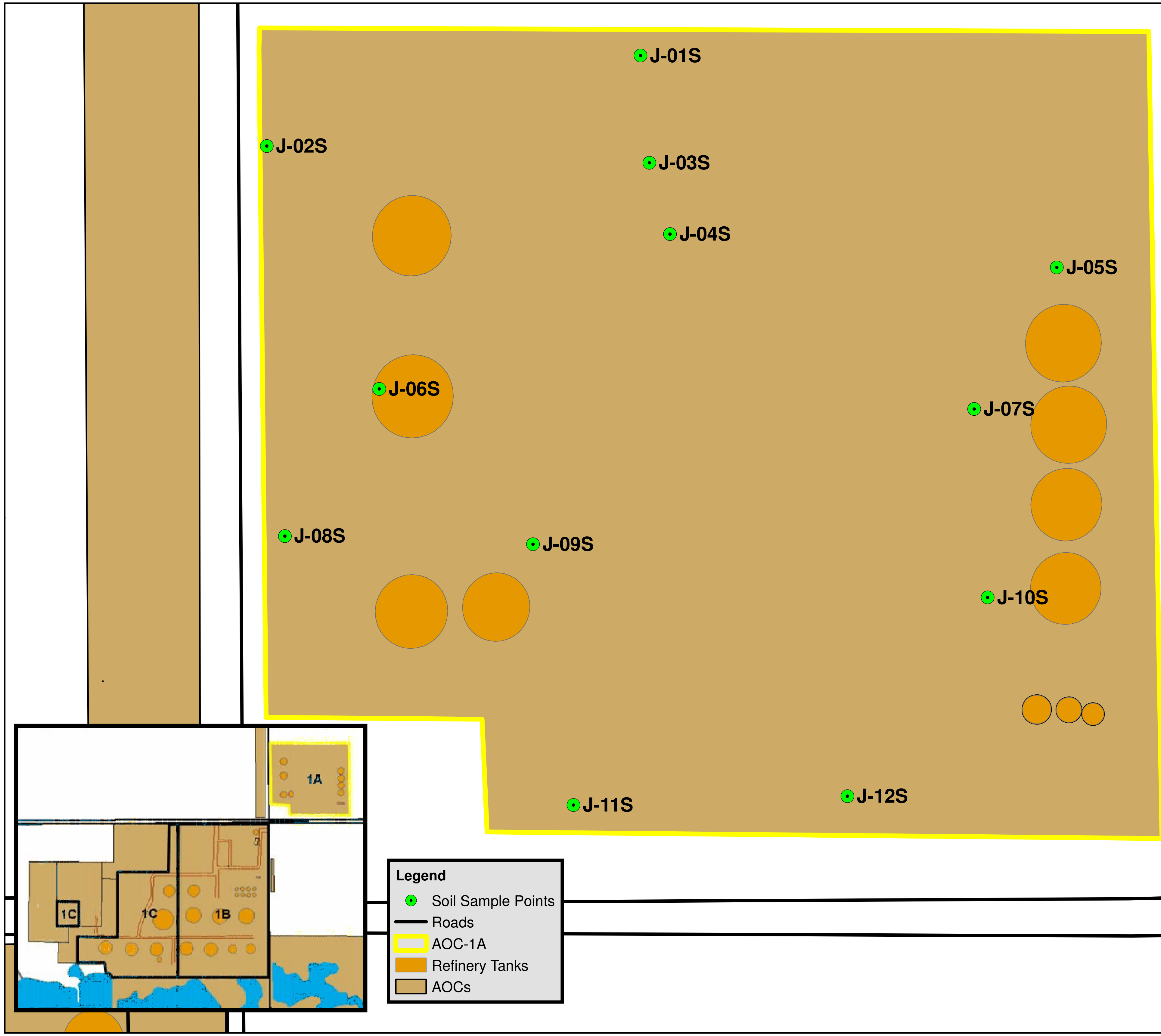
FIGURE
22C



J-01 S FR-014	
Acetone	0.0155 J
Cyclohexane	0.0054 J
Methylene chloride	0.0078 J

J-02 S FR-017	
Acetone	0.0234 J
Methylene chloride	0.0039 J

J-03 S FR-011	
Acetone	0.027 J
Methylene chloride	0.0072 J

J-04 S FR-008	
Ethylbenzene	0.0026 J
Methylene chloride	0.0101 J
Xylene (total)	0.0064 J

J-05 S FR-034	
1,2,4-Trimethylbenzene	0.0796
1,3,5-Trimethylbenzene	0.0175
Acetone	0.0697
Ethylbenzene	0.0275
Isopropylbenzene	0.0109
Methylene chloride	0.016
n-Butylbenzene	0.0149
n-Propylbenzene	0.0085
p-Isopropyltoluene	0.0032 J
Toluene	0.002 J
Xylene (total)	0.0217

J-06 S FR-021	
1,3,5-Trimethylbenzene	0.0051 J
Acetone	0.109
Methylene chloride	0.0048 J

J-07 S FR-031	
Acetone	0.0324 J
Methylene chloride	0.0143

J-08 S FR-023	
Acetone	0.249

J-09 S FR-026	
Acetone	0.0163 J
Methylene chloride	0.0042 J

J-10 S FR-028	
1,2,4-Trimethylbenzene	0.14
1,3,5-Trimethylbenzene	0.0667
Acetone	0.035 J
Ethylbenzene	0.0061
Isopropylbenzene	0.007
Methylene chloride	0.0076 J
n-Butylbenzene	0.0799
p-Isopropyltoluene	0.108
tert-Butylbenzene	0.152
Toluene	0.0035 J
Xylene (total)	0.0119 J

J-11 S FR-002	
Methylene chloride	0.0146

J-12 S FR-005	
Methylene chloride	0.0078 J

Notes:

1. Results are posted in mg/kg

2. Qualifiers:

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

N

0 50 100

Feet

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1A
Ecological
VOC Subsurface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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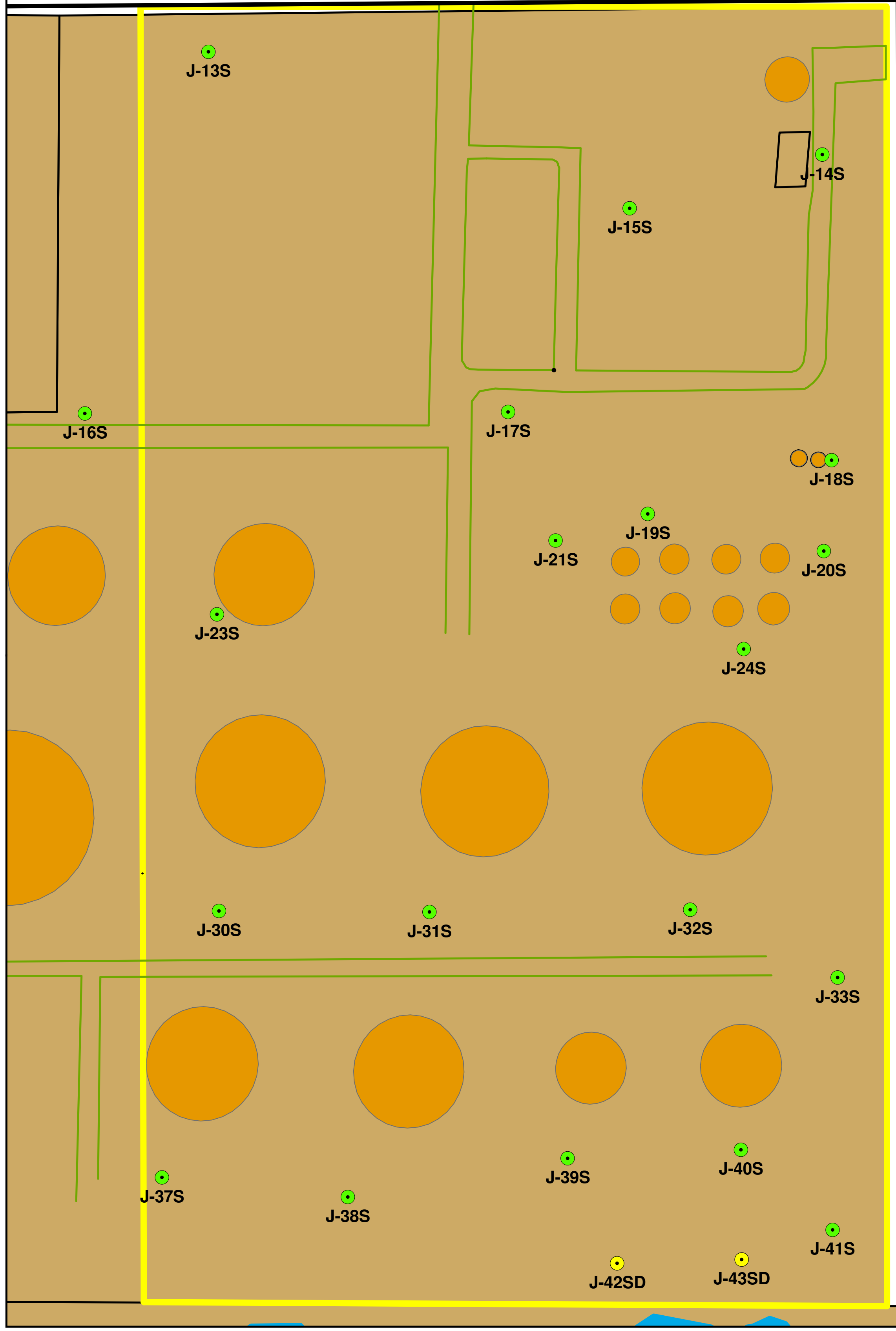
FIGURE

22D



J-13 S FR-065	
Acetone	0.0092 J

J-14 S FR-062	
Acetone	0.0127 J

J-15 S FR-036	
Acetone	0.0337 J
Methylene chloride	0.003 J

J-17 S FR-047	
Acetone	0.0265 J
Carbon disulfide	0.0021 J
Methylene chloride	0.0049 J

J-18 S FR-051	
Acetone	0.0219 J
Methylene chloride	0.006 J

J-19 S FR-041	
Carbon disulfide	0.002 J
Ethyl Ether	0.0133
Methylene chloride	0.0999

J-20 S FR-045	
Acetone	0.047 J
Methylene chloride	0.0334

J-23 S FR-055	
Acetone	0.0675

J-24 S FR-043	
Methylene chloride	0.0034 J

J-30 S FR-095	
Acetone	0.0109 J
Carbon disulfide	0.0023 J
Methylene chloride	0.0058 J

J-31 S FR-101	
Acetone	0.01 J

J-32 S FR-097	
Methylene chloride	0.0044 J

J-33 S FR-106	
Acetone	0.0127 J

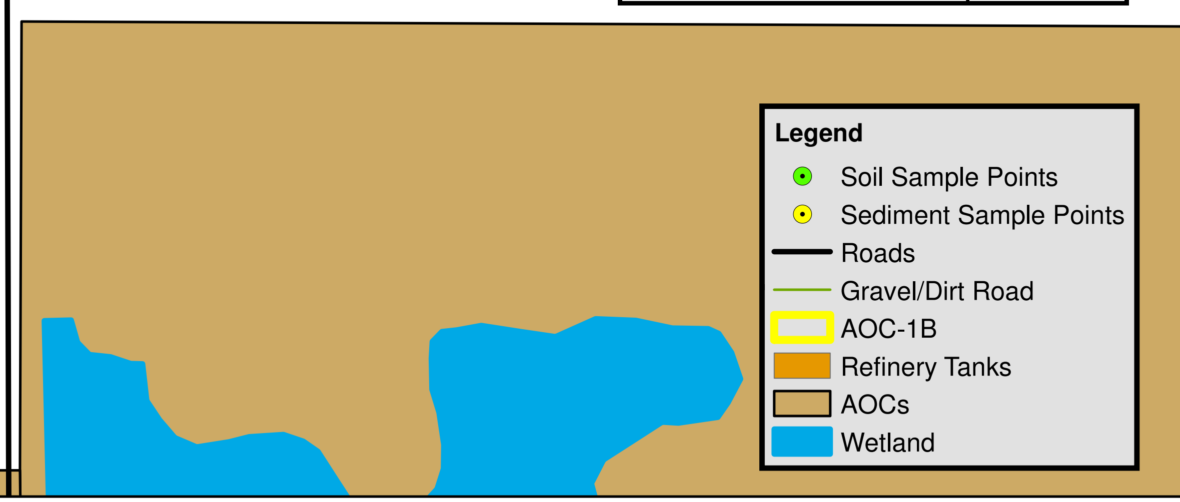
J-37 S FR-120	
Acetone	0.0268 J
Carbon disulfide	0.0041 J
Methylene chloride	0.0031 J

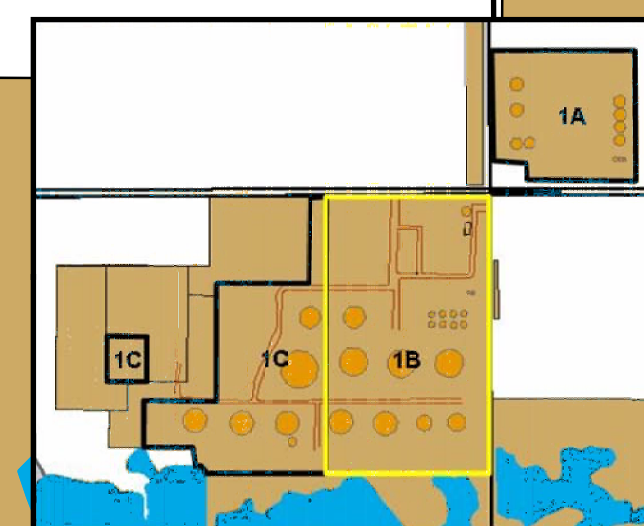
J-38 S FR-117	
Acetone	0.0326 J
Carbon disulfide	0.0016 J

J-39 S FR-114	
Acetone	0.0228 J

J-40 S FR-110A	
Acetone	0.01985 J
Carbon disulfide	0.00155 J

J-41 S FR-103	
Acetone	0.0082 J





Notes:

1. Results are posted in mg/kg
2. Qualifiers:

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

N

0 100 200

Feet

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1B
Ecological
VOC Subsurface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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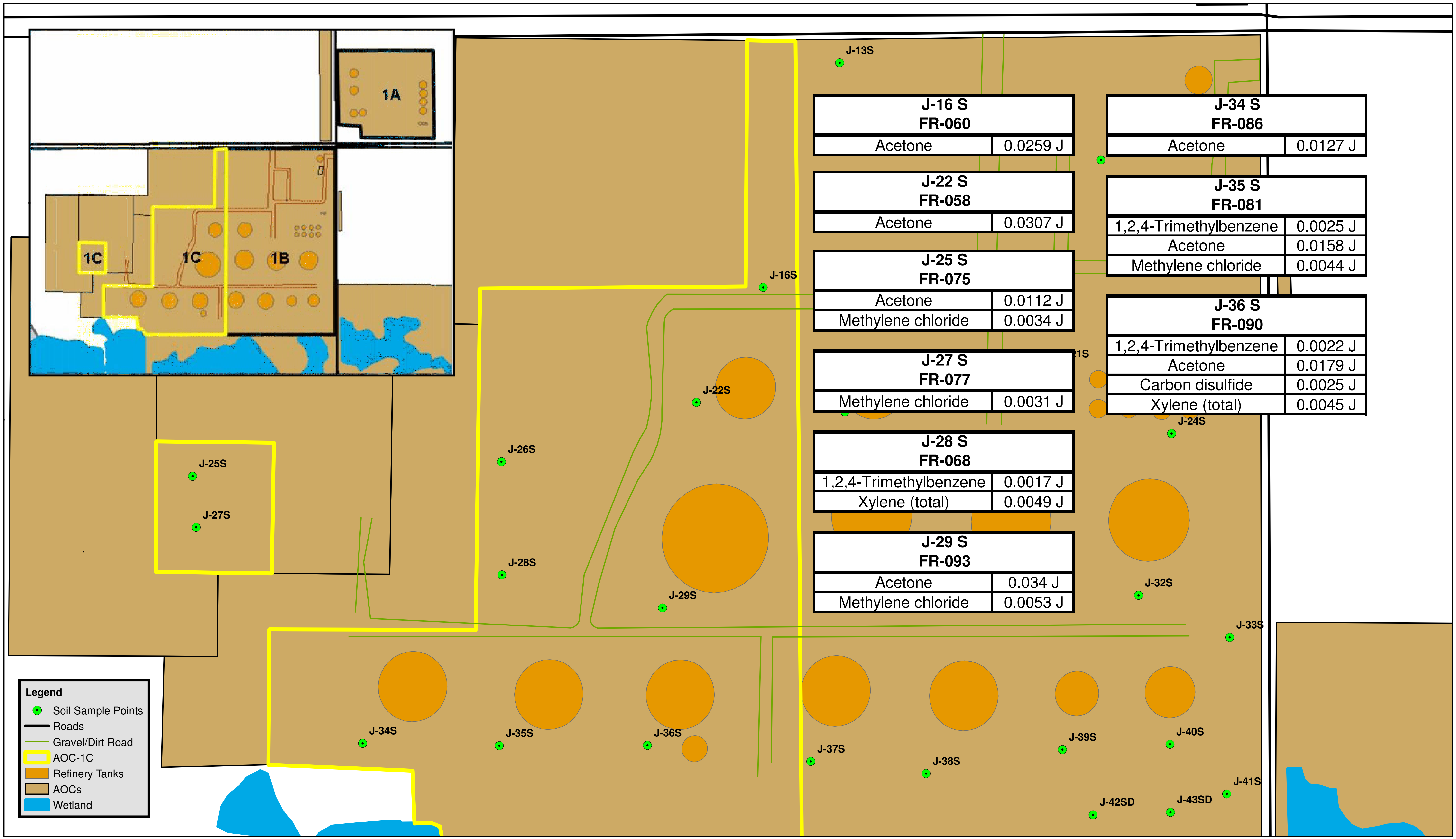
FIGURE

22E



Notes:

1. Results are posted in mg/kg

2. Qualifiers:

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

N

0 100 200

Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1C
Ecological
VOC Subsurface Soil Distribution Map

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INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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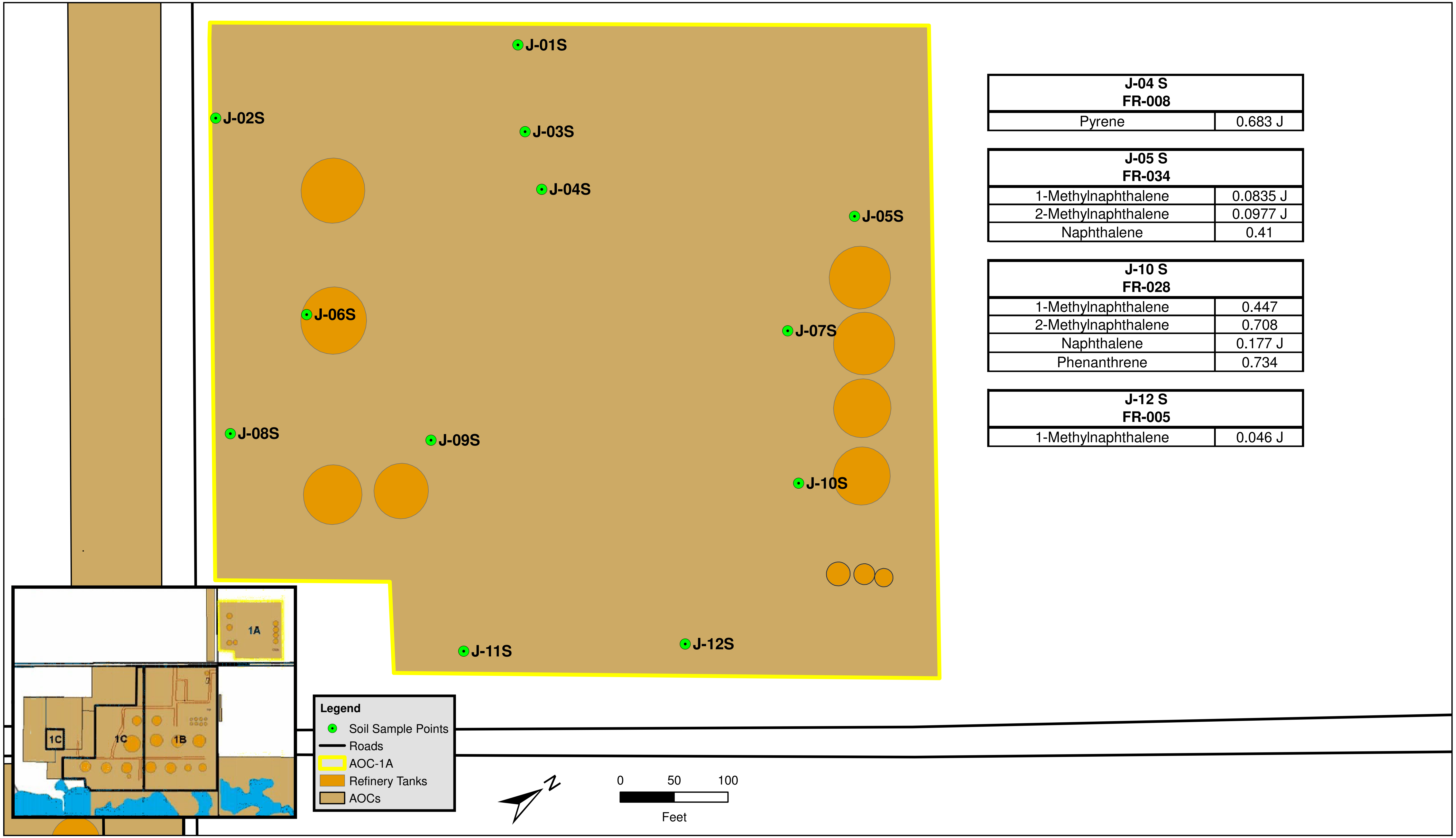
FIGURE
22F



J-04 S FR-008	
Pyrene	0.683 J

J-05 S FR-034	
1-Methylnaphthalene	0.0835 J
2-Methylnaphthalene	0.0977 J
Naphthalene	0.41

J-10 S FR-028	
1-Methylnaphthalene	0.447
2-Methylnaphthalene	0.708
Naphthalene	0.177 J
Phenanthrene	0.734

J-12 S FR-005	
1-Methylnaphthalene	0.046 J

Notes:

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2. Qualifiers:

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1A
Ecological
SVOC Subsurface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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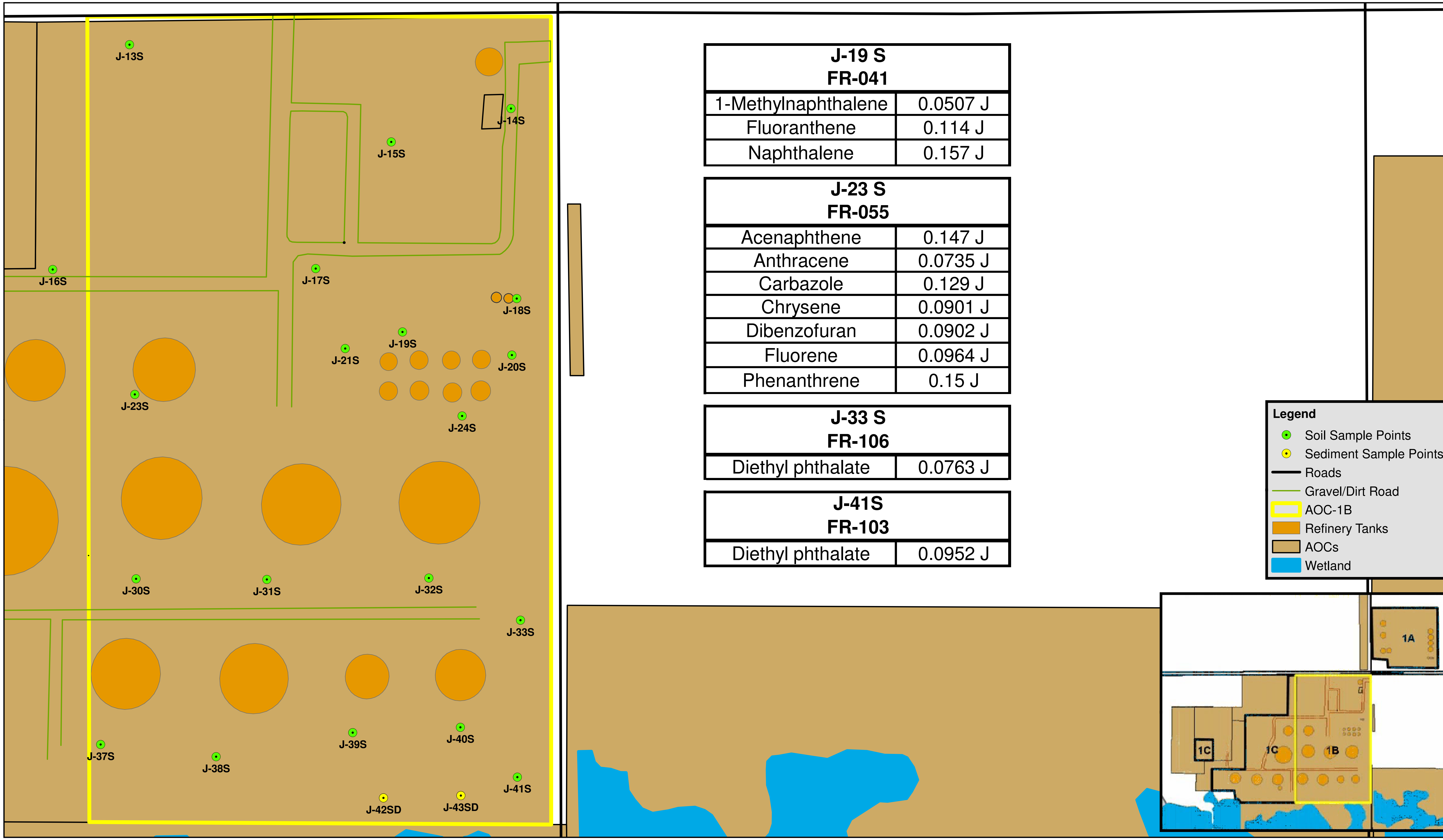
FIGURE
22G



J-19 S FR-041	
1-Methylnaphthalene	0.0507 J
Fluoranthene	0.114 J
Naphthalene	0.157 J

J-23 S FR-055	
Acenaphthene	0.147 J
Anthracene	0.0735 J
Carbazole	0.129 J
Chrysene	0.0901 J
Dibenzofuran	0.0902 J
Fluorene	0.0964 J
Phenanthrene	0.15 J

J-33 S FR-106	
Diethyl phthalate	0.0763 J

J-41S FR-103	
Diethyl phthalate	0.0952 J

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

N

0 100 200

Feet

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1B
Ecological
SVOC Subsurface Soil Distribution Map

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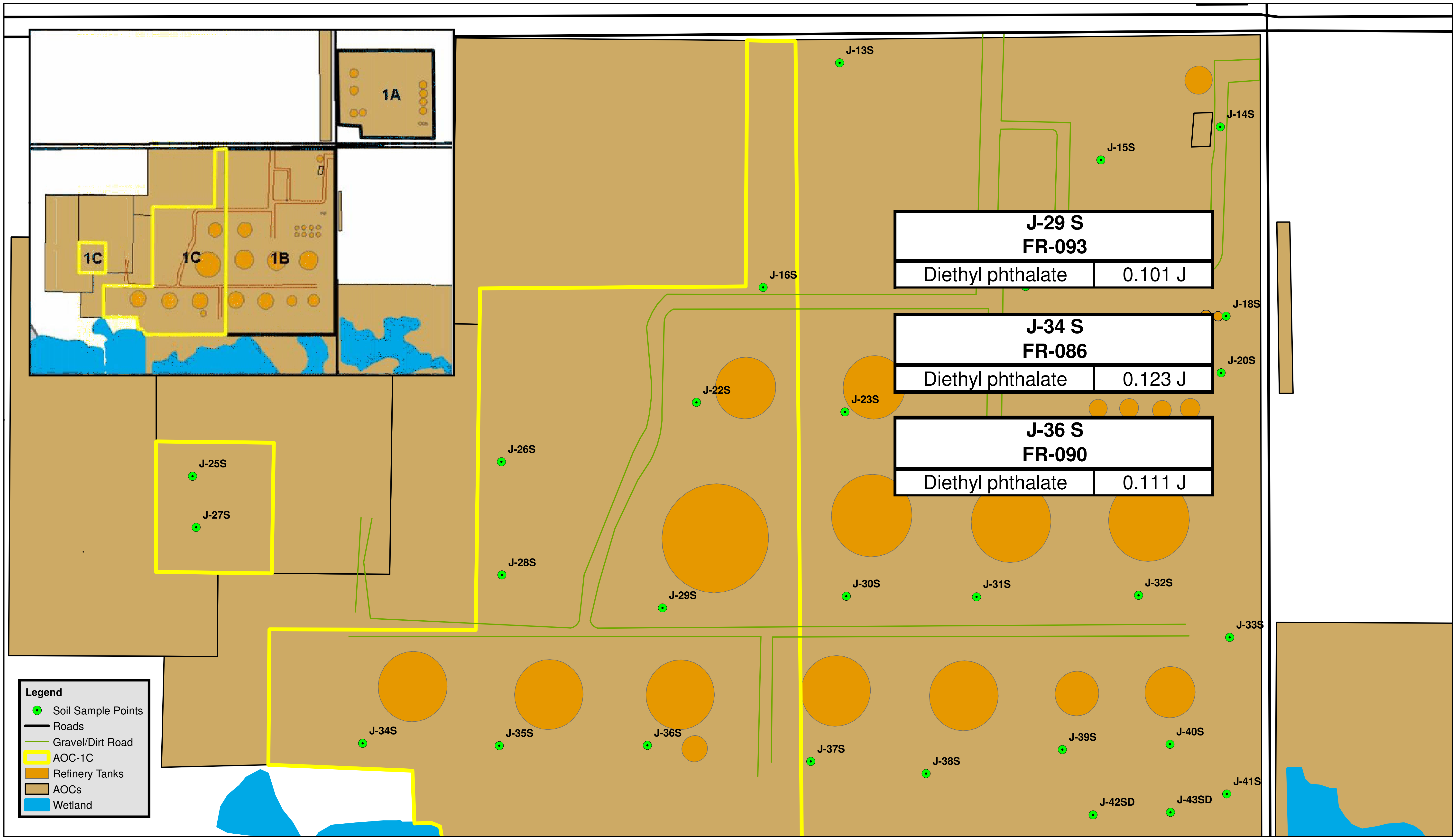
FIGURE
22H



Notes:

1. Results are posted in mg/kg

2. Qualifiers:

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

0 100 200

Feet

DATE DRAWN:	DATE REVISED:
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DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1C
Ecological
SVOC Subsurface Soil Distribution Map

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INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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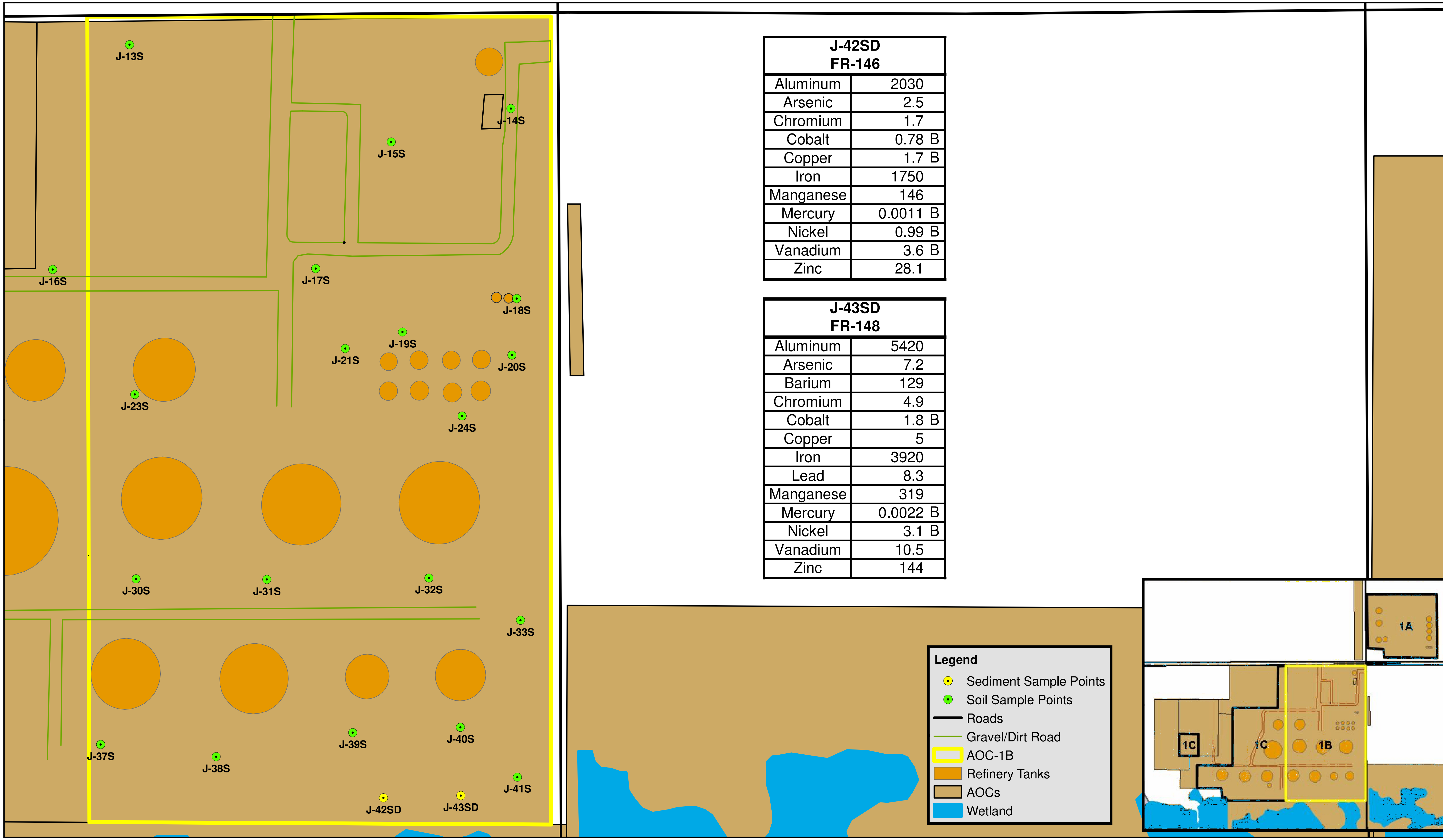
FIGURE

22I



J-42SD FR-146	
Aluminum	2030
Arsenic	2.5
Chromium	1.7
Cobalt	0.78 B
Copper	1.7 B
Iron	1750
Manganese	146
Mercury	0.0011 B
Nickel	0.99 B
Vanadium	3.6 B
Zinc	28.1

J-43SD FR-148	
Aluminum	5420
Arsenic	7.2
Barium	129
Chromium	4.9
Cobalt	1.8 B
Copper	5
Iron	3920
Lead	8.3
Manganese	319
Mercury	0.0022 B
Nickel	3.1 B
Vanadium	10.5
Zinc	144

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

   B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

N

0 100 200

Feet

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1B
Ecological
Metal Sediment Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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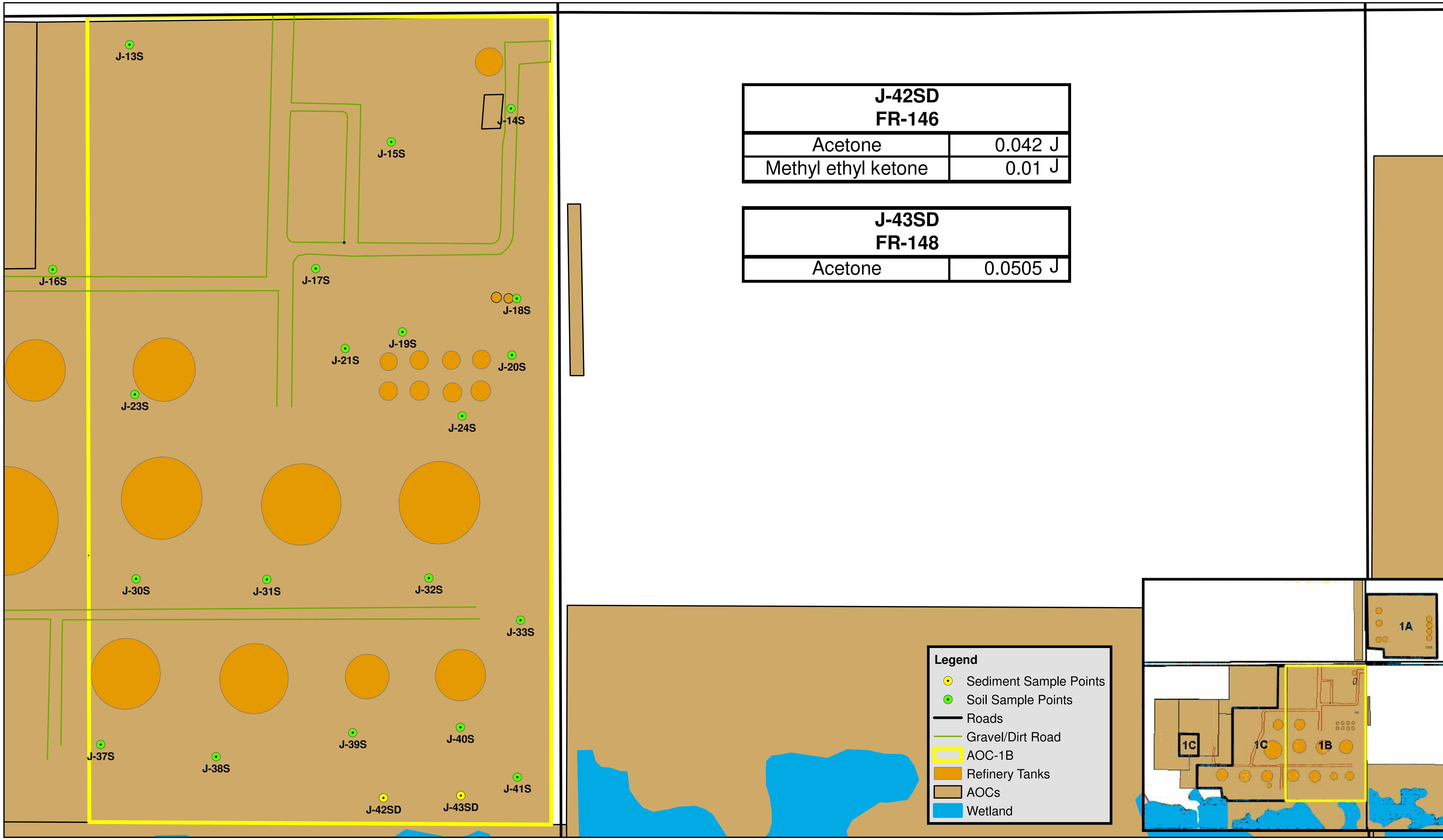
FIGURE
23A



J-42SD FR-146	
Acetone	0.042 J
Methyl ethyl ketone	0.01 J

J-43SD FR-148	
Acetone	0.0505 J

Notes:

1. Results are posted in mg/kg

2. Qualifiers:

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
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APPROVED BY:	

AOC-1B
Ecological
VOC Sediment Distribution Map

FALCON REFINERY
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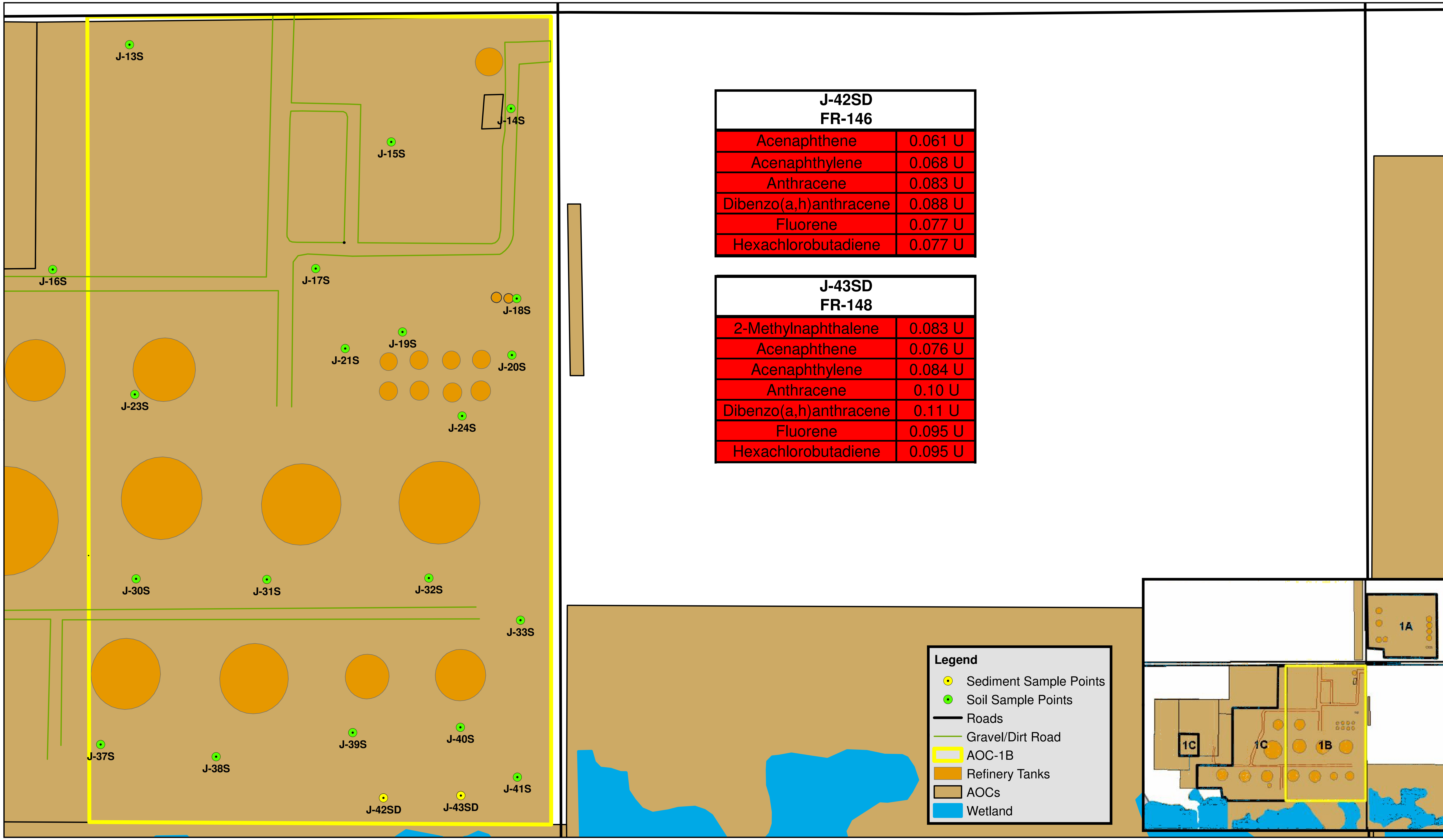
FIGURE
23B



J-42SD FR-146	
Acenaphthene	0.061 U
Acenaphthylene	0.068 U
Anthracene	0.083 U
Dibenzo(a,h)anthracene	0.088 U
Fluorene	0.077 U
Hexachlorobutadiene	0.077 U

J-43SD FR-148	
2-Methylnaphthalene	0.083 U
Acenaphthene	0.076 U
Acenaphthylene	0.084 U
Anthracene	0.10 U
Dibenzo(a,h)anthracene	0.11 U
Fluorene	0.095 U
Hexachlorobutadiene	0.095 U

Notes:

1. Results are posted in mg/kg

2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

Exceeds Sediment Marine Screening Level

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1B
Ecological
SVOC Sediment Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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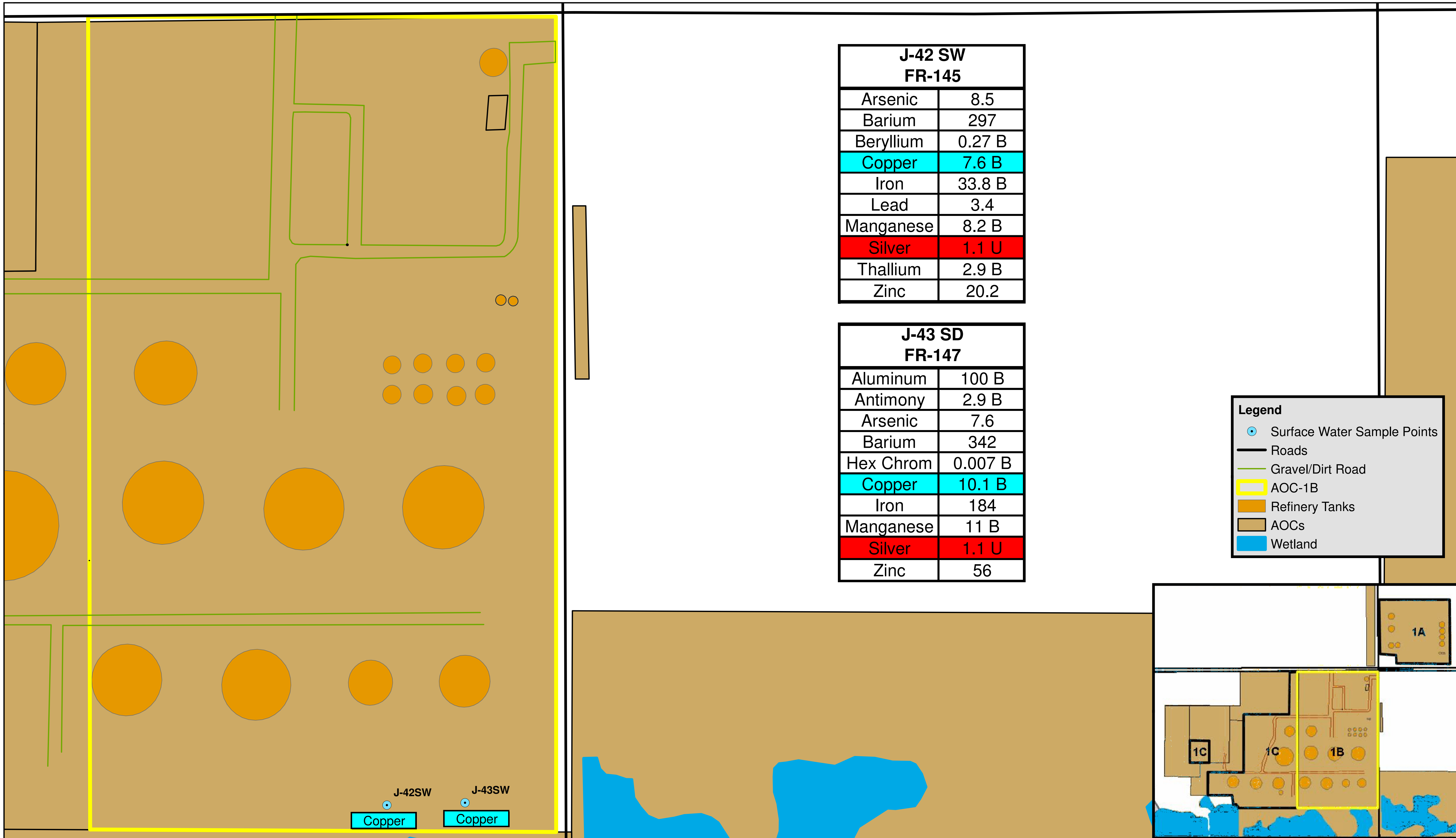
FIGURE
23C



J-42 SW FR-145	
Arsenic	8.5
Barium	297
Beryllium	0.27 B
Copper	7.6 B
Iron	33.8 B
Lead	3.4
Manganese	8.2 B
Silver	1.1 U
Thallium	2.9 B
Zinc	20.2

J-43 SD FR-147	
Aluminum	100 B
Antimony	2.9 B
Arsenic	7.6
Barium	342
Hex Chrom	0.007 B
Copper	10.1 B
Iron	184
Manganese	11 B
Silver	1.1 U
Zinc	56

Notes:

1. Results are posted in µg/l
   Hex Chrom posted in mg/l
2. Qualifiers:
   U = Undetected at the sample detection limit (SDL)
   B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Above Marine Limit

Exceeds Marine Screening Level

N

0 90 180
Feet

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-1B Ecological Metal Surface Water Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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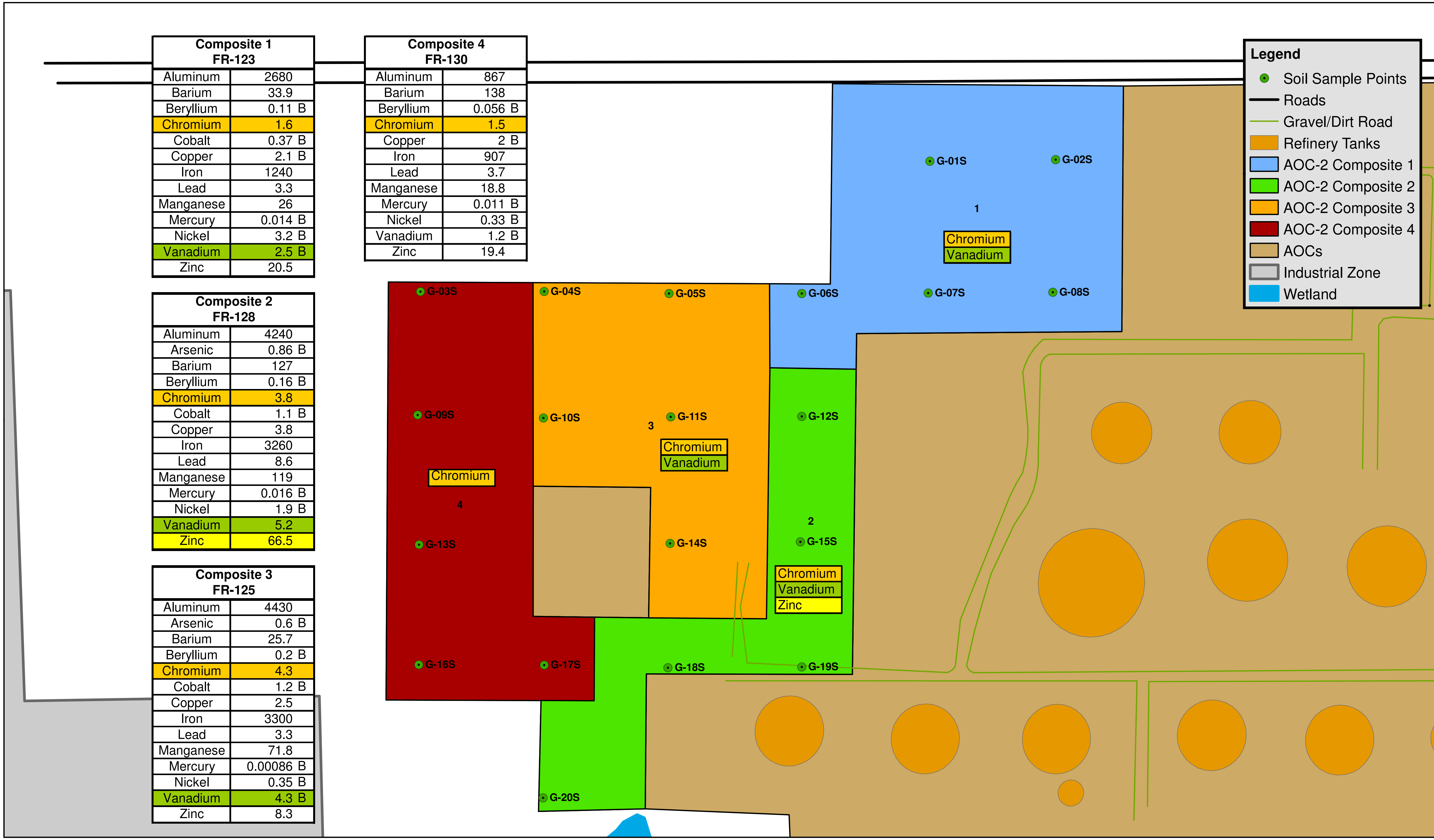
FIGURE
24

Composite 1 FR-123	
Aluminum	2680
Barium	33.9
Beryllium	0.11 B
Chromium	1.6
Cobalt	0.37 B
Copper	2.1 B
Iron	1240
Lead	3.3
Manganese	26
Mercury	0.014 B
Nickel	3.2 B
Vanadium	2.5 B
Zinc	20.5

Composite 2 FR-128	
Aluminum	4240
Arsenic	0.86 B
Barium	127
Beryllium	0.16 B
Chromium	3.8
Cobalt	1.1 B
Copper	3.8
Iron	3260
Lead	8.6
Manganese	119
Mercury	0.016 B
Nickel	1.9 B
Vanadium	5.2
Zinc	66.5

Composite 3 FR-125	
Aluminum	4430
Arsenic	0.6 B
Barium	25.7
Beryllium	0.2 B
Chromium	4.3
Cobalt	1.2 B
Copper	2.5
Iron	3300
Lead	3.3
Manganese	71.8
Mercury	0.00086 B
Nickel	0.35 B
Vanadium	4.3 B
Zinc	8.3

Composite 4 FR-130	
Aluminum	867
Barium	138
Beryllium	0.056 B
Chromium	1.5
Copper	2 B
Iron	907
Lead	3.7
Manganese	18.8
Mercury	0.011 B
Nickel	0.33 B
Vanadium	1.2 B
Zinc	19.4



Notes:

1. Results are posted in mg/kg
2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds Plant Limit
Exceeds Median Background Limit
Exceeds Earthworm and Plant Limits

N

0 100 200
Feet

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09
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CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-2
Ecological
Metal Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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FIGURE
25A

Composite 2	
FR-128	
Methylene Chloride	0.0048 J

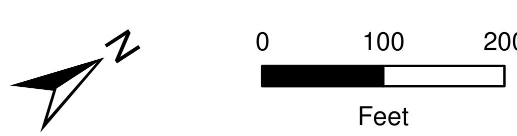
Composite 4	
FR-130	
Acetone	0.0136 J
Methylene Chloride	0.0076 J

Notes:

1. Results are posted in mg/kg

2. Qualifiers:

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)



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CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-2
Ecological
VOC Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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FIGURE

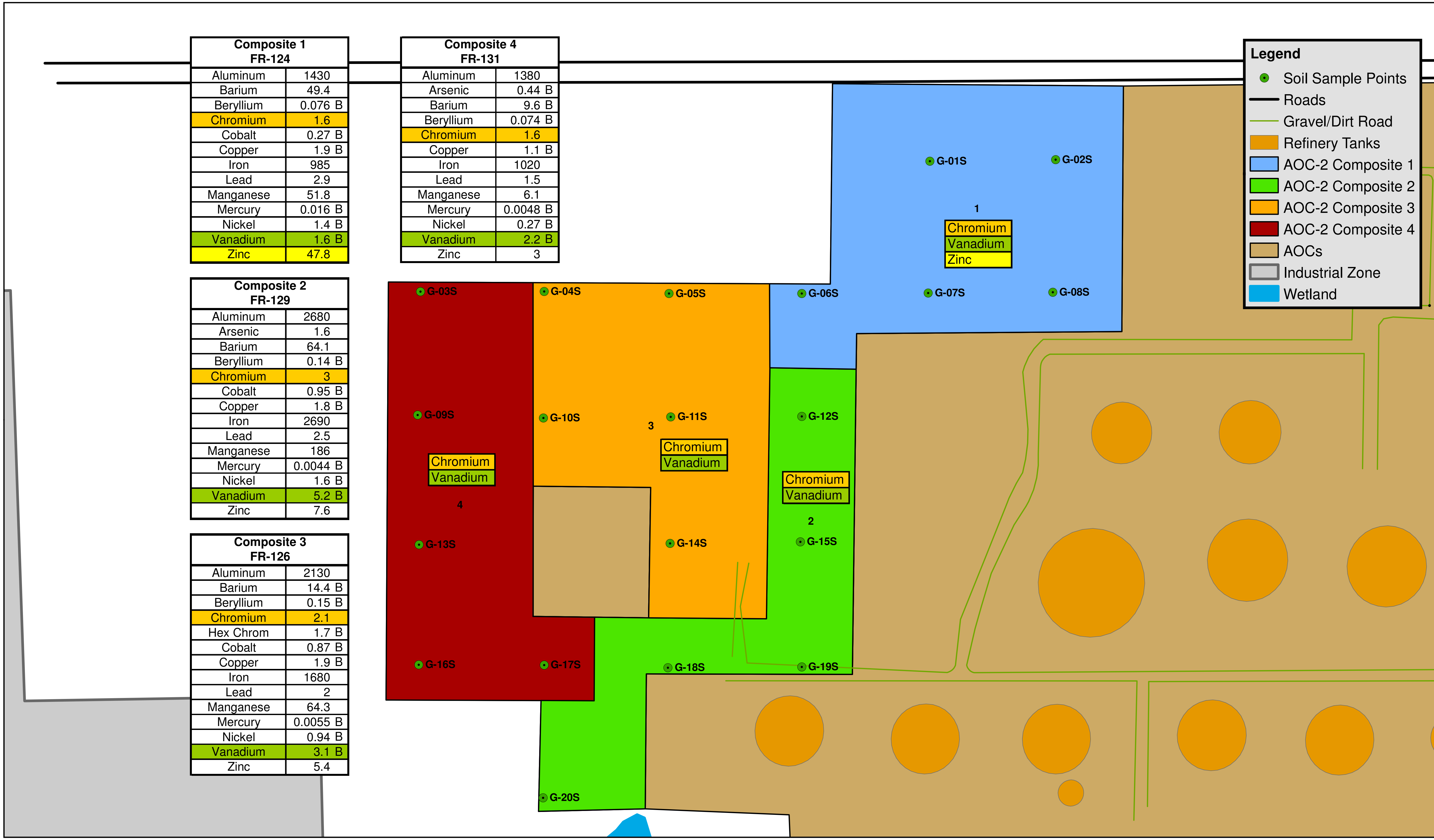
25B

Composite 1 FR-124	
Aluminum	1430
Barium	49.4
Beryllium	0.076 B
Chromium	1.6
Cobalt	0.27 B
Copper	1.9 B
Iron	985
Lead	2.9
Manganese	51.8
Mercury	0.016 B
Nickel	1.4 B
Vanadium	1.6 B
Zinc	47.8

Composite 4 FR-131	
Aluminum	1380
Arsenic	0.44 B
Barium	9.6 B
Beryllium	0.074 B
Chromium	1.6
Copper	1.1 B
Iron	1020
Lead	1.5
Manganese	6.1
Mercury	0.0048 B
Nickel	0.27 B
Vanadium	2.2 B
Zinc	3

Composite 2 FR-129	
Aluminum	2680
Arsenic	1.6
Barium	64.1
Beryllium	0.14 B
Chromium	3
Cobalt	0.95 B
Copper	1.8 B
Iron	2690
Lead	2.5
Manganese	186
Mercury	0.0044 B
Nickel	1.6 B
Vanadium	5.2 B
Zinc	7.6

Composite 3 FR-126	
Aluminum	2130
Barium	14.4 B
Beryllium	0.15 B
Chromium	2.1
Hex Chrom	1.7 B
Cobalt	0.87 B
Copper	1.9 B
Iron	1680
Lead	2
Manganese	64.3
Mercury	0.0055 B
Nickel	0.94 B
Vanadium	3.1 B
Zinc	5.4



Legend

- Soil Sample Points
- Roads
- Gravel/Dirt Road
- Refinery Tanks
- AOC-2 Composite 1
- AOC-2 Composite 2
- AOC-2 Composite 3
- AOC-2 Composite 4
- AOCs
- Industrial Zone
- Wetland

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

- Exceeds Plant Limit
- Exceeds Median Background Limit
- Exceeds Earthworm and Plant Limits

N

0 100 200

Feet

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-2
Ecological
Metal Subsurface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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FIGURE
26A

Composite 1	
FR-124	
Acetone	0.0298 J

Composite 2	
FR-129	
Acetone	0.0256 J
Methylene Chloride	0.0066 J

Composite 3	
FR-126	
Acetone	0.011 J

Composite 4	
FR-131	
Acetone	0.0202 J
Methylene Chloride	0.0062 J

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

DATE DRAWN: 4/30/08	DATE REVISED: 4/1/09		
DRAFTED BY:	C. SEATON		
CHECKED BY:	S. HALASZ		
APPROVED BY:			
PROJ NO.	59752	FILE NAME:	Falcon Refinery Base Map

AOC-2
Ecological
VOC Subsurface Soil Distribution Map

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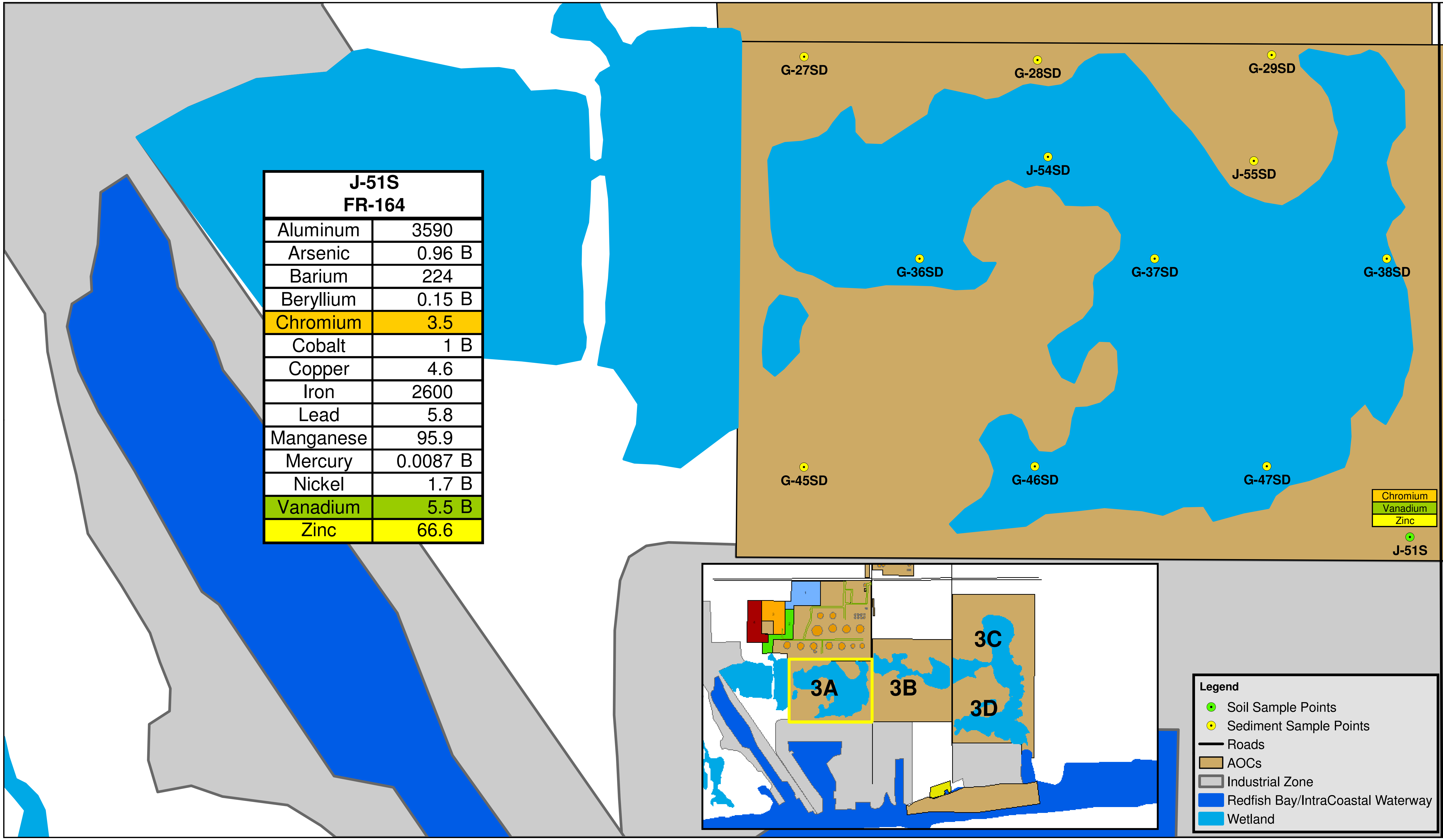
FIGURE
26B



J-51S FR-164	
Aluminum	3590
Arsenic	0.96 B
Barium	224
Beryllium	0.15 B
Chromium	3.5
Cobalt	1 B
Copper	4.6
Iron	2600
Lead	5.8
Manganese	95.9
Mercury	0.0087 B
Nickel	1.7 B
Vanadium	5.5 B
Zinc	66.6

Notes:

1. Results are posted in mg/kg

2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds Plant Limit
Exceeds Median Background Limit
Exceeds Earthworm and Plant Limits

N

0 100 200

Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-3A
Ecological
Metal Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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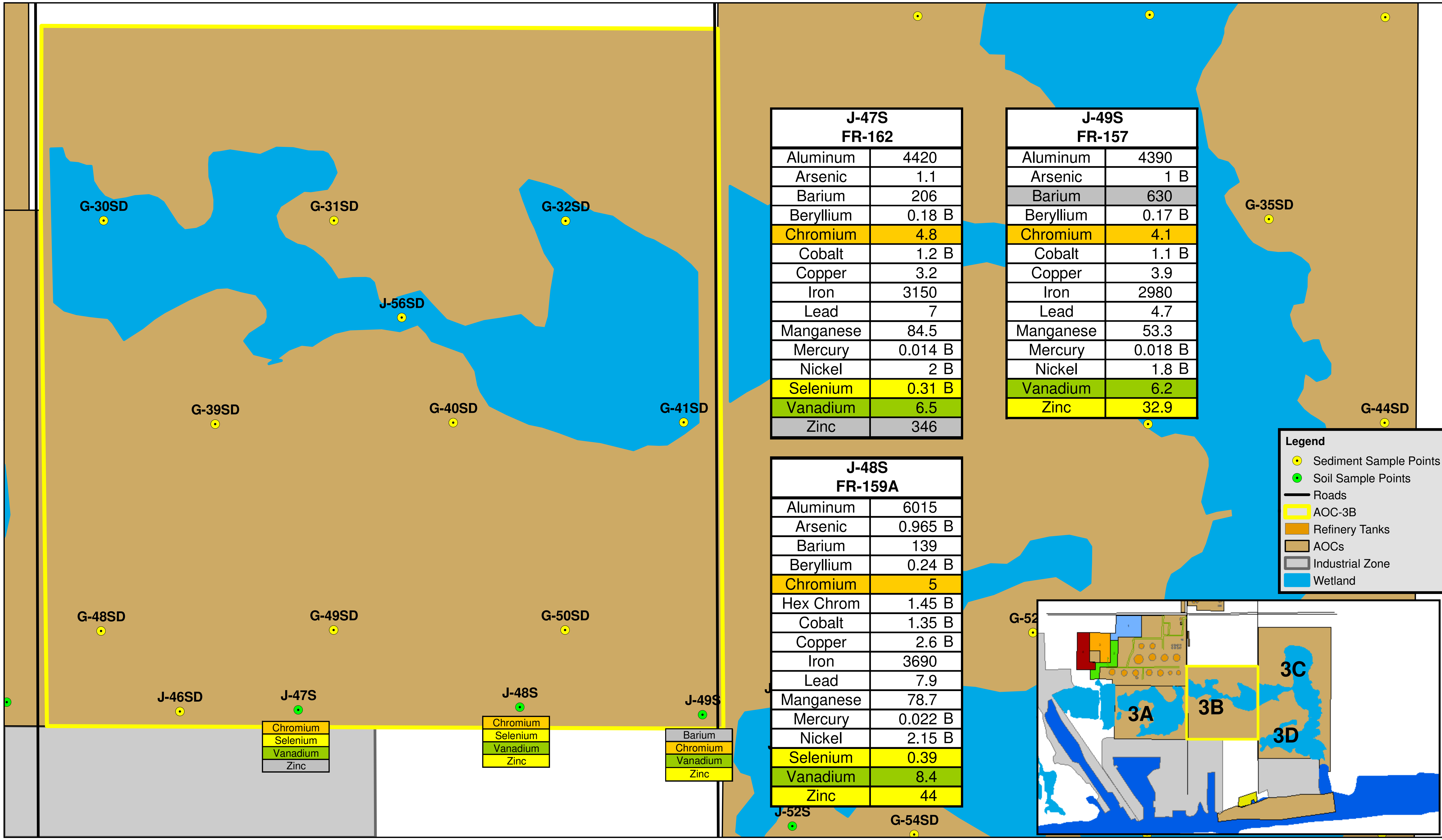
FIGURE
27A



J-47S FR-162	
Aluminum	4420
Arsenic	1.1
Barium	206
Beryllium	0.18 B
Chromium	4.8
Cobalt	1.2 B
Copper	3.2
Iron	3150
Lead	7
Manganese	84.5
Mercury	0.014 B
Nickel	2 B
Selenium	0.31 B
Vanadium	6.5
Zinc	346

J-49S FR-157	
Aluminum	4390
Arsenic	1 B
Barium	630
Beryllium	0.17 B
Chromium	4.1
Cobalt	1.1 B
Copper	3.9
Iron	2980
Lead	4.7
Manganese	53.3
Mercury	0.018 B
Nickel	1.8 B
Vanadium	6.2
Zinc	32.9

J-48S FR-159A	
Aluminum	6015
Arsenic	0.965 B
Barium	139
Beryllium	0.24 B
Chromium	5
Hex Chrom	1.45 B
Cobalt	1.35 B
Copper	2.6 B
Iron	3690
Lead	7.9
Manganese	78.7
Mercury	0.022 B
Nickel	2.15 B
Selenium	0.39
Vanadium	8.4
Zinc	44

Notes:

1. Results are posted in mg/kg

2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

- Exceeds Plant Limit
- Exceeds Median Background Limit
- Exceeds Earthworm and Plant Limits
- Exceeds Earthworm, Plant, and Median Background Limits

N

0 100 200

Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
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APPROVED BY:	

AOC-3B
Ecological
Metal Surface Soil Distribution Map

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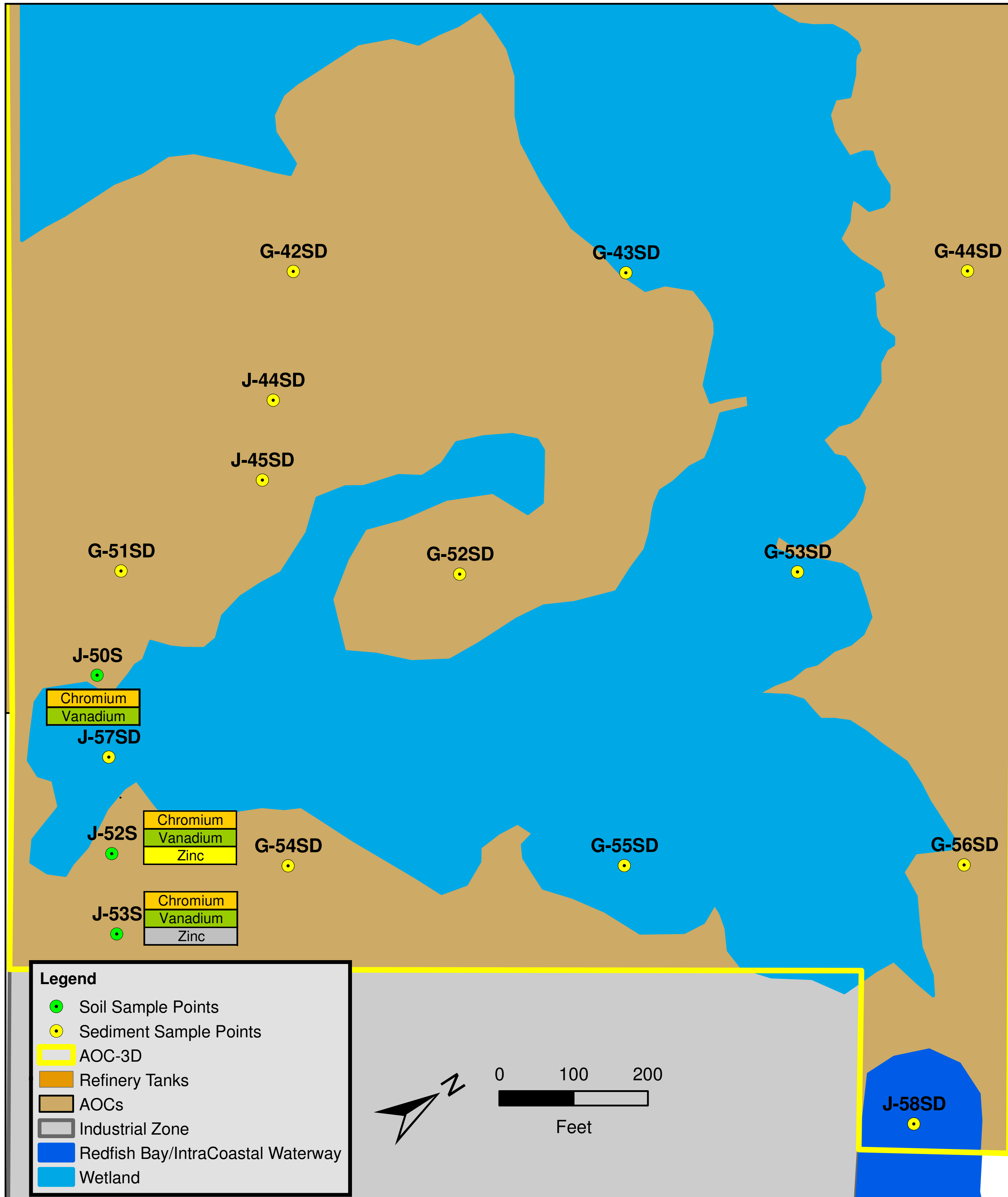
FIGURE

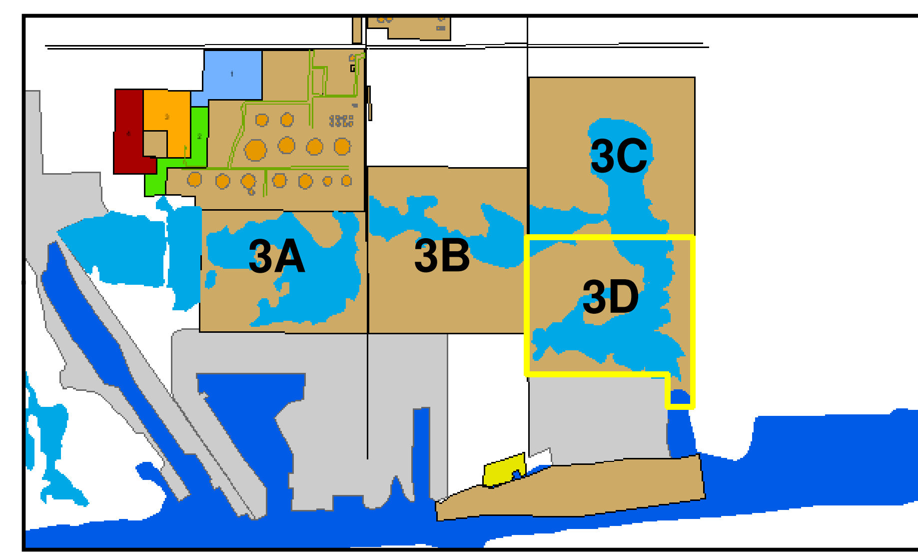
27B



J-50S FR-155	
Aluminum	1760
Arsenic	0.72 B
Barium	16.6 B
Beryllium	0.074 B
Chromium	1.4
Cobalt	0.36 B
Copper	2.5 B
Iron	1160
Lead	3.3
Manganese	226
Mercury	0.008 B
Nickel	0.59 B
Vanadium	2.5 B
Zinc	23.9

J-53S FR-136	
Aluminum	3420
Arsenic	2.5
Barium	74.4
Beryllium	0.21 B
Chromium	5.9
Cobalt	0.93 B
Copper	3.9
Iron	3050
Lead	13.5
Manganese	113
Mercury	0.0049 B
Nickel	2.5 B
Vanadium	6.3
Zinc	279

J-52S FR-138	
Aluminum	4590
Arsenic	1 B
Barium	37.9
Beryllium	0.23 B
Chromium	3.6
Cobalt	0.92 B
Copper	4.2
Iron	2450
Lead	4.5
Manganese	100
Mercury	0.008 B
Nickel	2.1 B
Selenium	0.32 U
Vanadium	6.1 B
Zinc	32.8



Notes:

1. Results are posted in mg/kg
2. Qualifiers:
   U = Undetected at the sample detection limit (SDL)
   B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

- Exceeds Plant Limit
- Exceeds Median Background Limit
- Exceeds Earthworm and Plant Limits
- Exceeds Earthworm, Plant, and Median Background Limits
- SDL Exceeds Median Background Screening Level

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
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CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-3D
Ecological
Metal Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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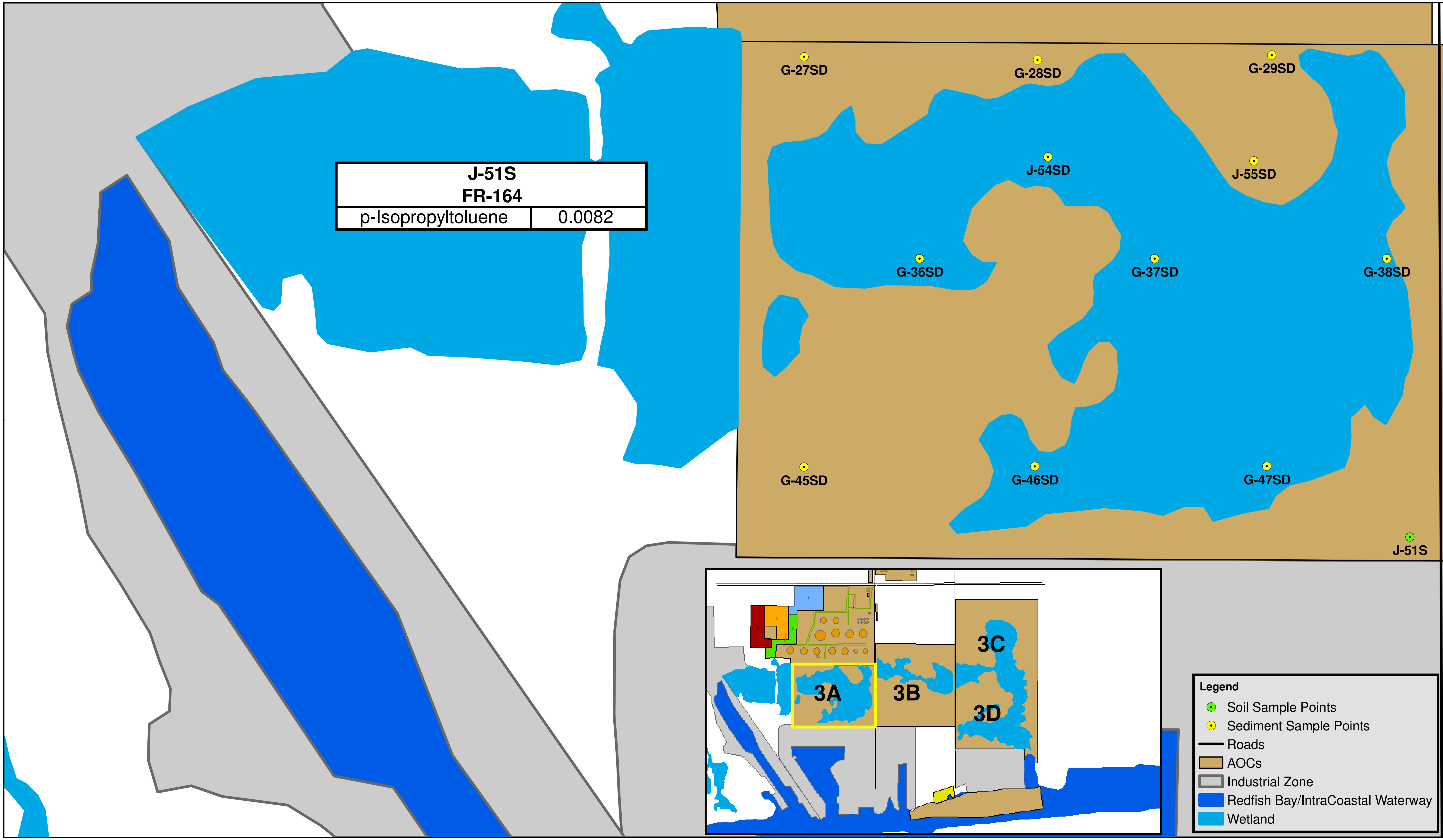
FIGURE
27C



Notes:

1. Results are posted in mg/kg

Z

0 100 200

Feet

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CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-3A
Ecological
VOC Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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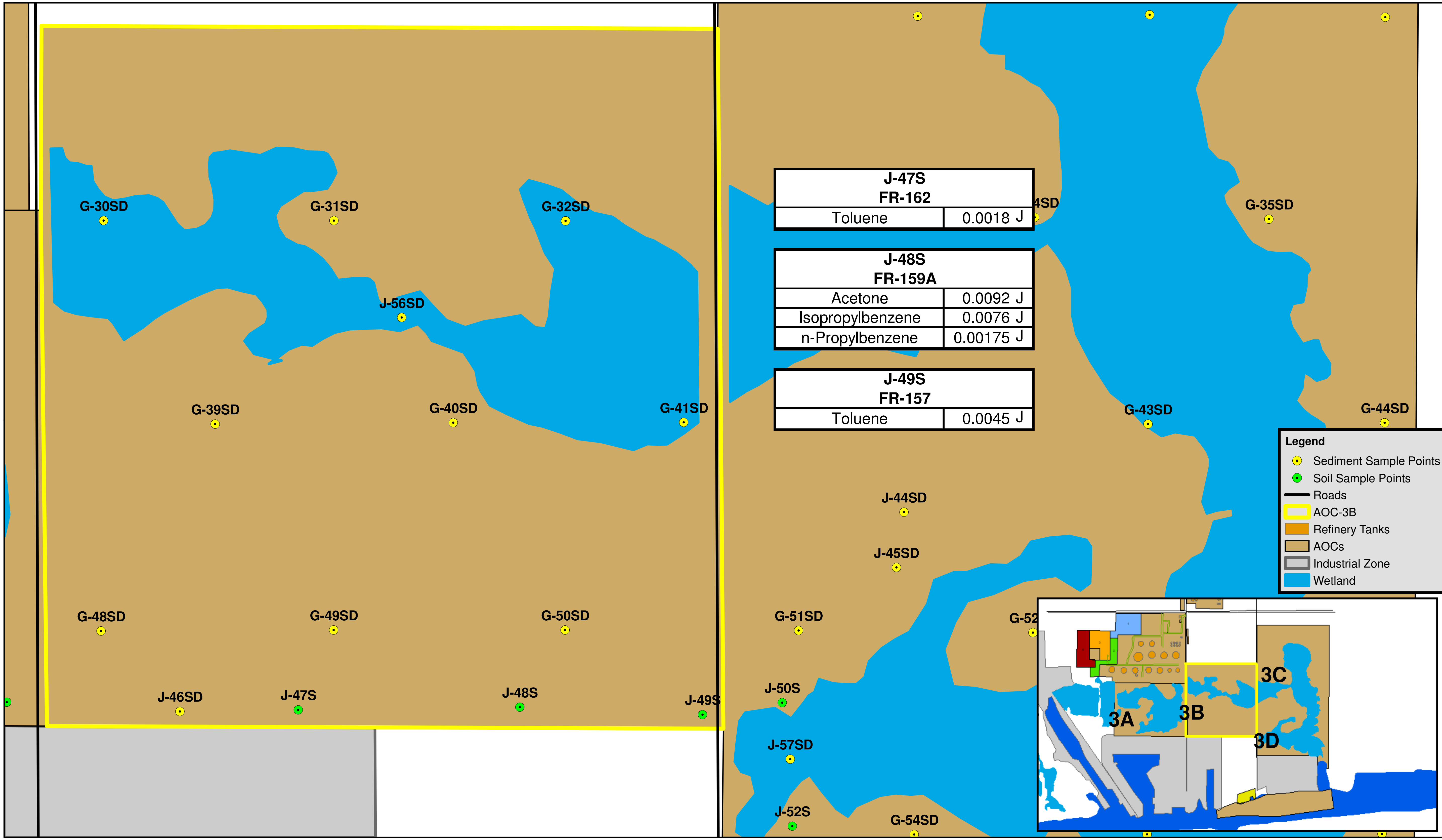
FIGURE
27D



Notes:

1. Results are posted in mg/kg
2. Qualifiers:

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

N

0 100 200

Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09	**AOC-3B Ecological VOC Surface Soil Distribution Map**
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CHECKED BY:	S. HALASZ	FALCON REFINERY INGLESIDE, SAN PATRICIO COUNTY, TEXAS
APPROVED BY:		
PROJ NO. 59752		FILE NAME: Falcon Refinery Base Map

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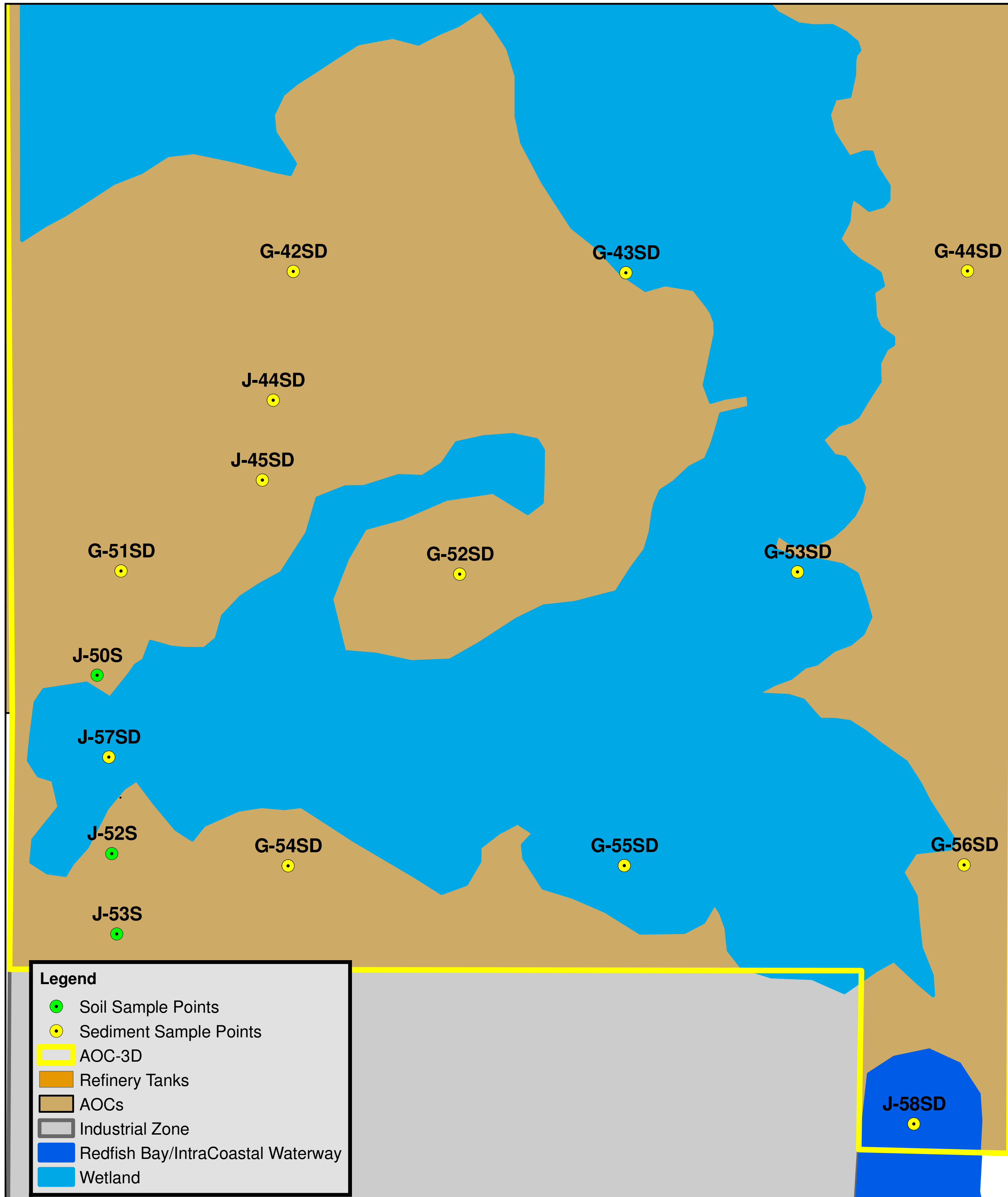
FIGURE

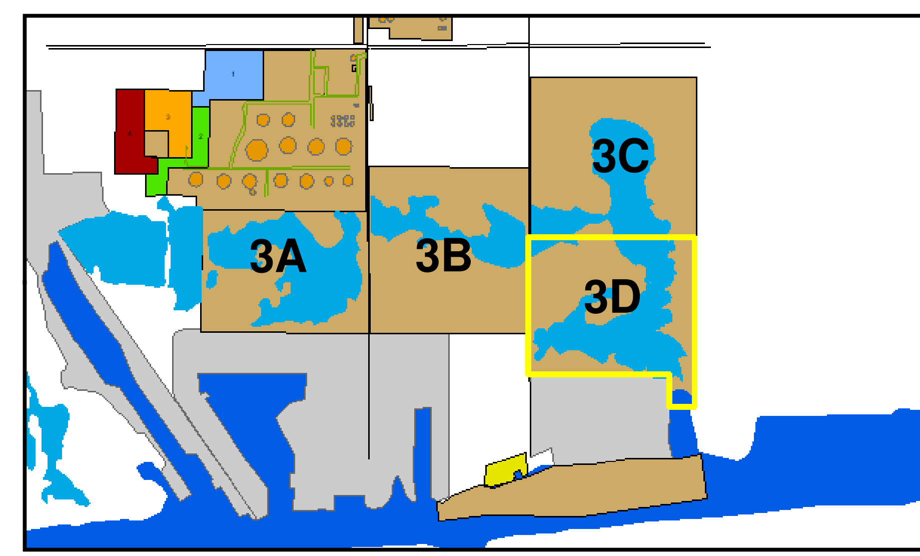
27E



J-50S FR-155	
Toluene	0.0021 J

J-52S FR-138	
p-Isopropyltoluene	0.0019 J

J-53S FR-136	
Methylene chloride	0.0052 J



Notes:

1. Results are posted in mg/kg
2. Qualifiers:

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

N

0 100 200

Feet

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CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-3D
Ecological
VOC Surface Soil Distribution Map

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FIGURE
27F

J-51S FR-164	
Benzo(a)anthracene	0.0946 J
Benzo(b)fluoranthene	0.108 J
Chrysene	0.109 J
Fluoranthene	0.14 J
Phenanthrene	0.083 J
Pyrene	0.201

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

N

0 100 200
Feet

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DRAFTED BY: C. SEATON
CHECKED BY: S. HALASZ
APPROVED BY:

AOC-3A Ecological SVOC Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752
FILE NAME: Falcon Refinery Base Map

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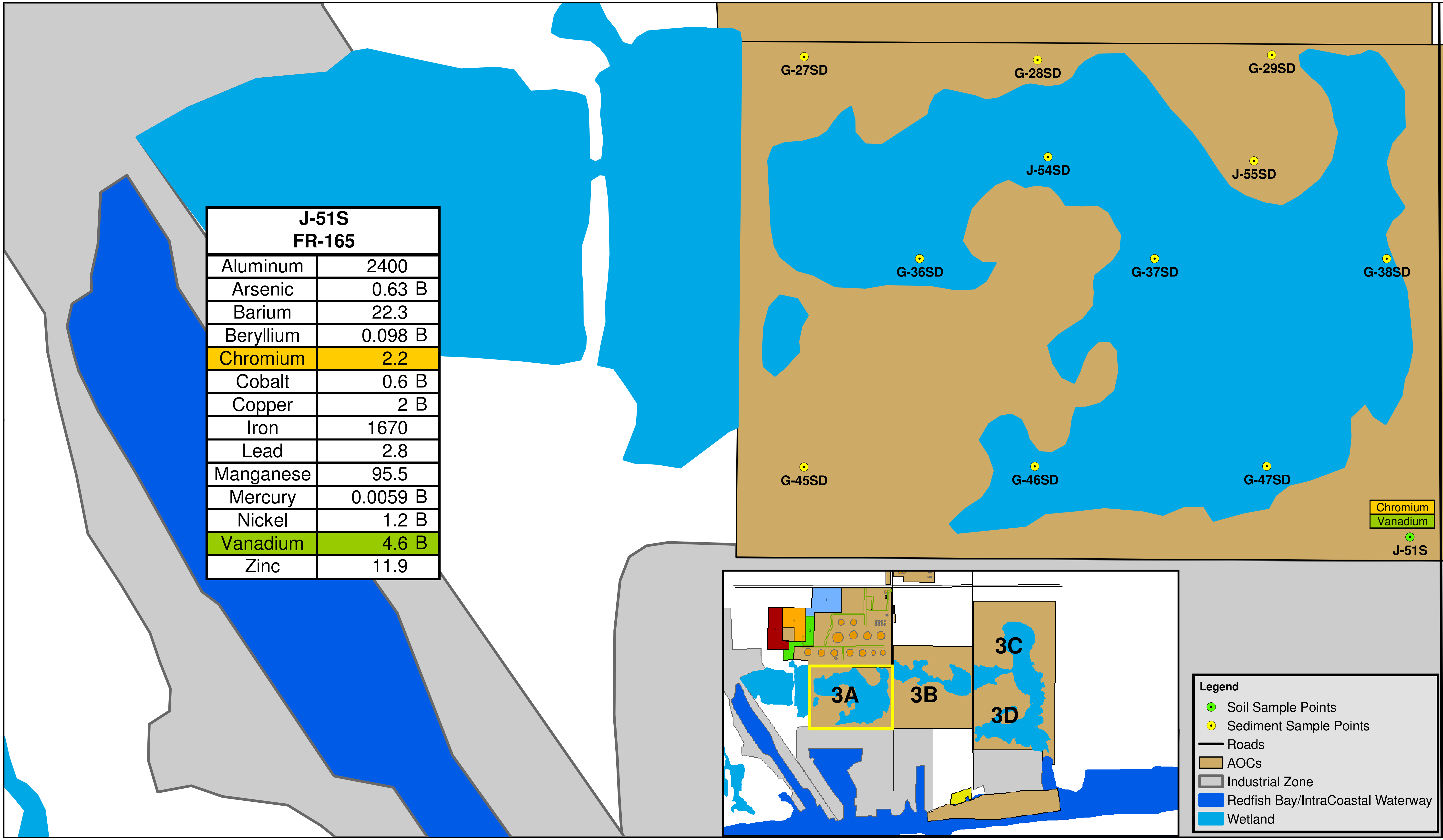
FIGURE
27G



J-51S FR-165	
Aluminum	2400
Arsenic	0.63 B
Barium	22.3
Beryllium	0.098 B
Chromium	2.2
Cobalt	0.6 B
Copper	2 B
Iron	1670
Lead	2.8
Manganese	95.5
Mercury	0.0059 B
Nickel	1.2 B
Vanadium	4.6 B
Zinc	11.9

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds Plant Limit

Exceeds Earthworm and Plant Limits

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-3A
Ecological
Metal Subsurface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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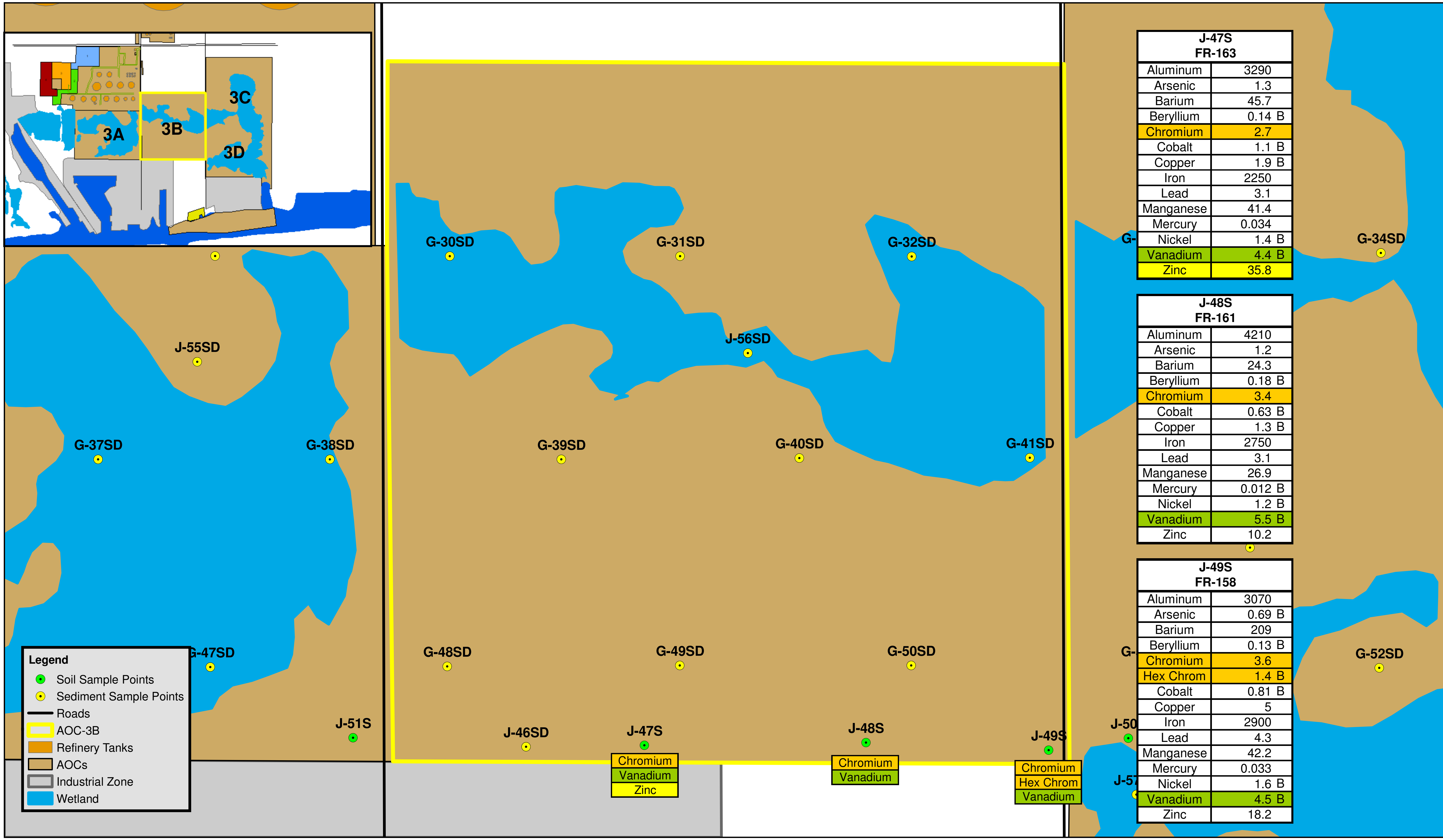
FIGURE
28A



J-47S FR-163	
Aluminum	3290
Arsenic	1.3
Barium	45.7
Beryllium	0.14 B
Chromium	2.7
Cobalt	1.1 B
Copper	1.9 B
Iron	2250
Lead	3.1
Manganese	41.4
Mercury	0.034
Nickel	1.4 B
Vanadium	4.4 B
Zinc	35.8

J-48S FR-161	
Aluminum	4210
Arsenic	1.2
Barium	24.3
Beryllium	0.18 B
Chromium	3.4
Cobalt	0.63 B
Copper	1.3 B
Iron	2750
Lead	3.1
Manganese	26.9
Mercury	0.012 B
Nickel	1.2 B
Vanadium	5.5 B
Zinc	10.2

J-49S FR-158	
Aluminum	3070
Arsenic	0.69 B
Barium	209
Beryllium	0.13 B
Chromium	3.6
Hex Chrom	1.4 B
Cobalt	0.81 B
Copper	5
Iron	2900
Lead	4.3
Manganese	42.2
Mercury	0.033
Nickel	1.6 B
Vanadium	4.5 B
Zinc	18.2

Notes:

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2. Qualifiers:

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Exceeds Plant Limit

Exceeds Median Background Limit

Exceeds Earthworm and Plant Limits

N

0 110 220

Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
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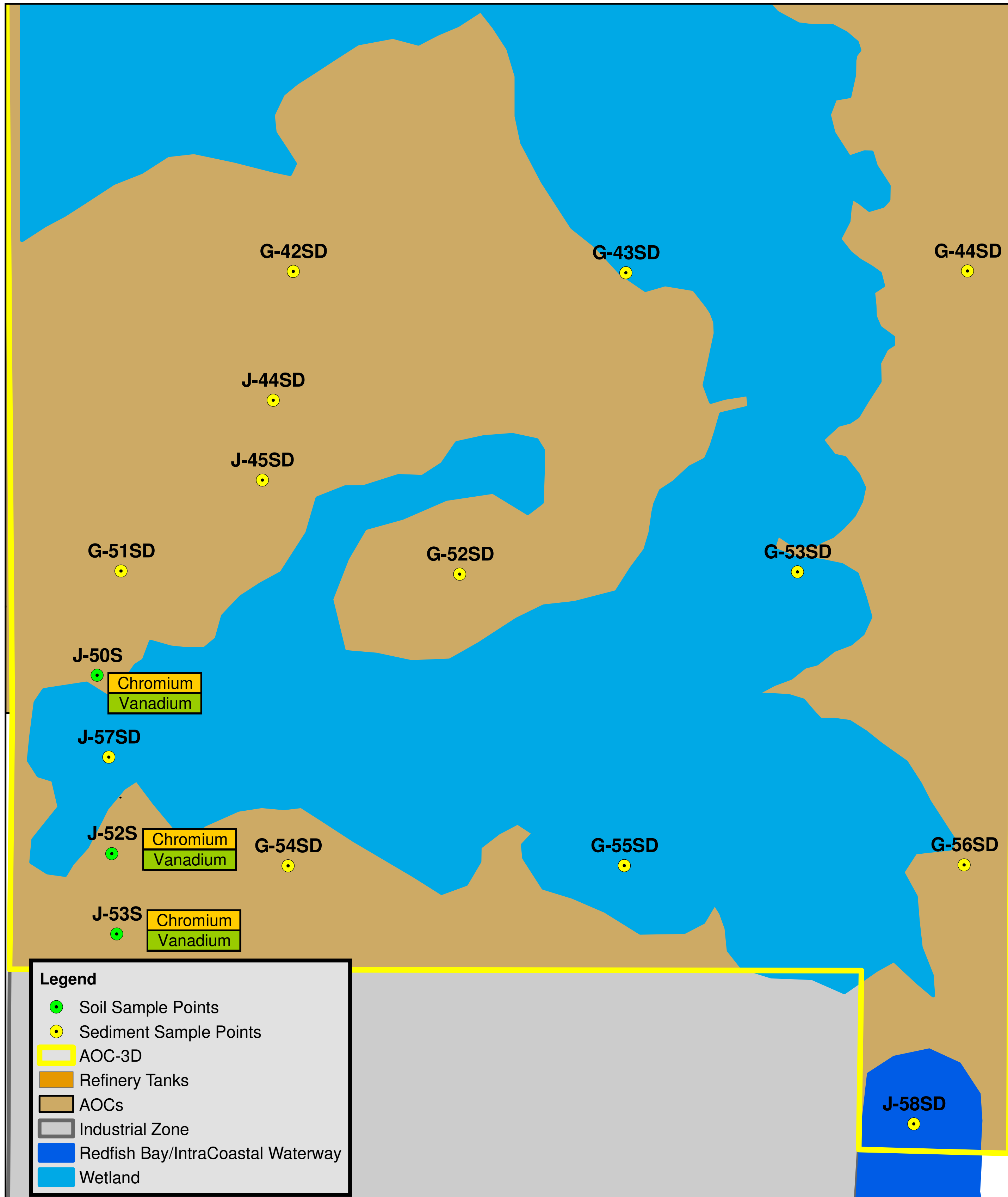
FIGURE

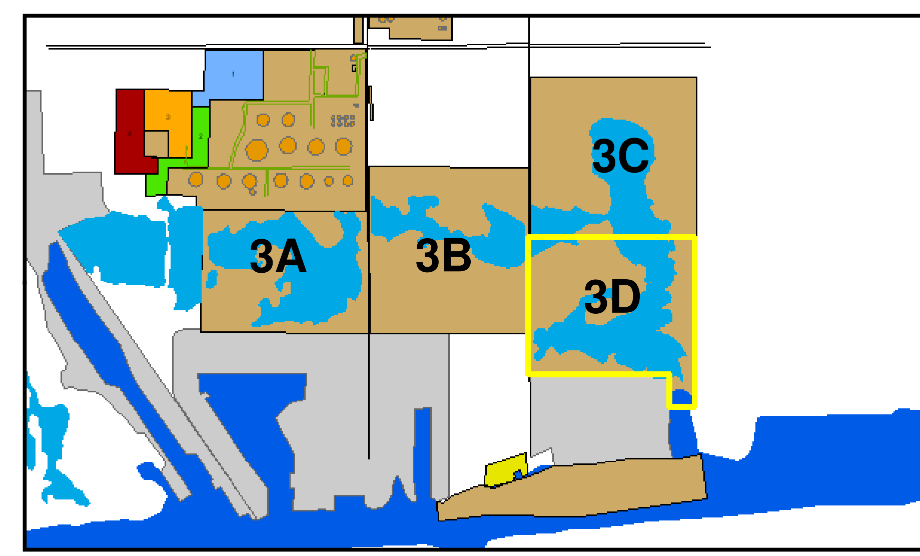
28B



J-50S FR-156	
Aluminum	4600
Arsenic	0.52 B
Barium	45.5
Beryllium	0.19 B
Chromium	3.2
Cobalt	1.1 B
Copper	2.6 B
Iron	3060
Lead	2.7
Manganese	76.3
Mercury	0.0065 B
Nickel	1.8 B
Vanadium	5.1 B
Zinc	13.7

J-53S FR-137	
Aluminum	4260
Arsenic	2.4
Barium	17.9 B
Beryllium	0.2 B
Chromium	3.9
Cobalt	0.88 B
Copper	2.3 B
Iron	2680
Lead	2.5
Manganese	113
Mercury	0.002 B
Nickel	2.3 B
Vanadium	7.9
Zinc	17.5

J-52S FR-139	
Aluminum	3570
Arsenic	1.1 B
Barium	21.6 B
Beryllium	0.19 B
Chromium	4
Cobalt	0.8 B
Copper	2 B
Iron	2300
Lead	2.4
Manganese	114
Mercury	0.0023 B
Nickel	1.9 B
Vanadium	5.3 B
Zinc	8.9



Notes:

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Exceeds Plant Limit

Exceeds Earthworm and Plant Limits

0 110 220

Feet

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Ecological
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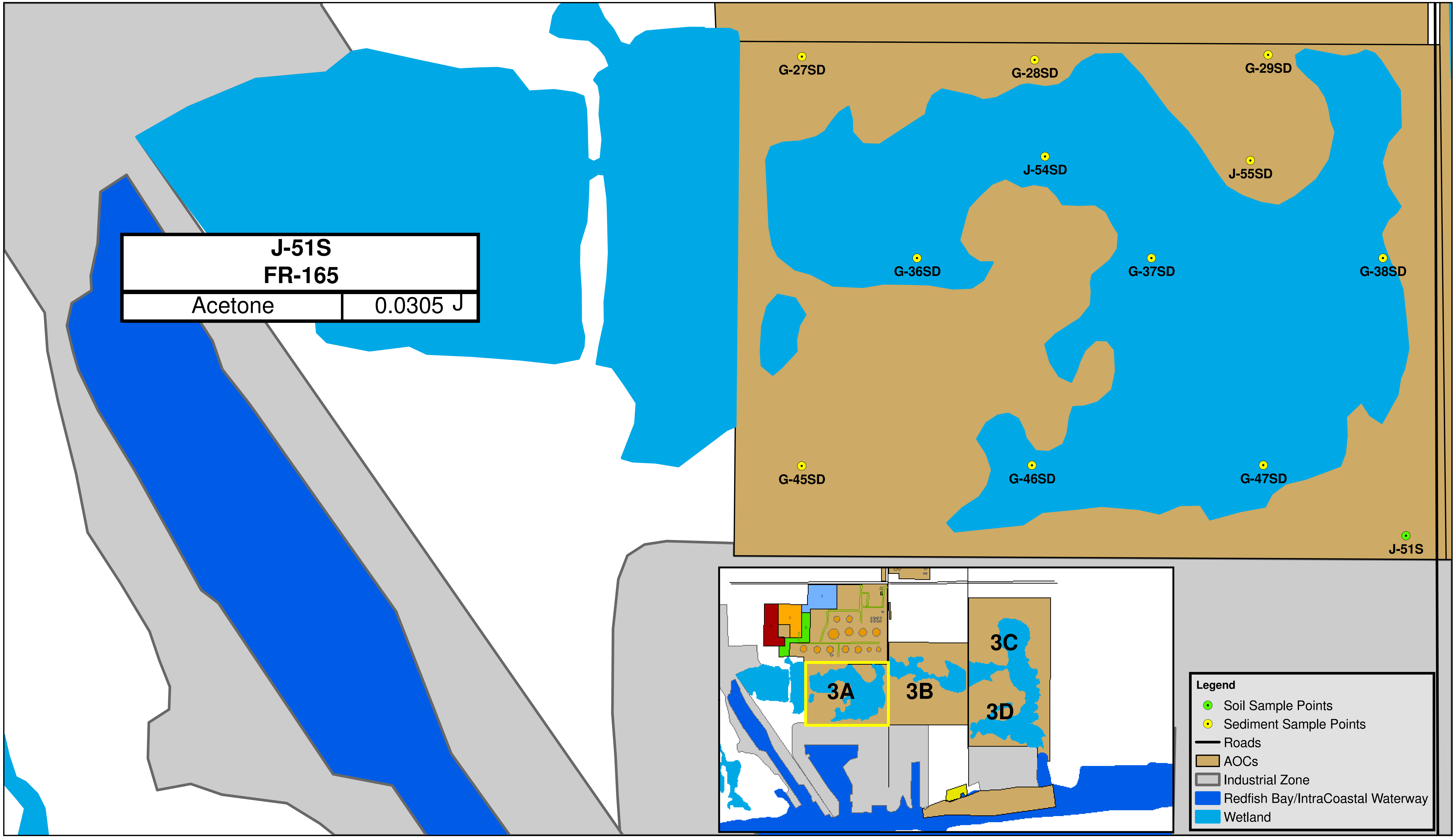
FIGURE

28C



Notes:

1. Results are posted in mg/kg
2. Qualifiers:

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

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APPROVED BY:	

AOC-3A
Ecological
VOC Subsurface Soil Distribution Map

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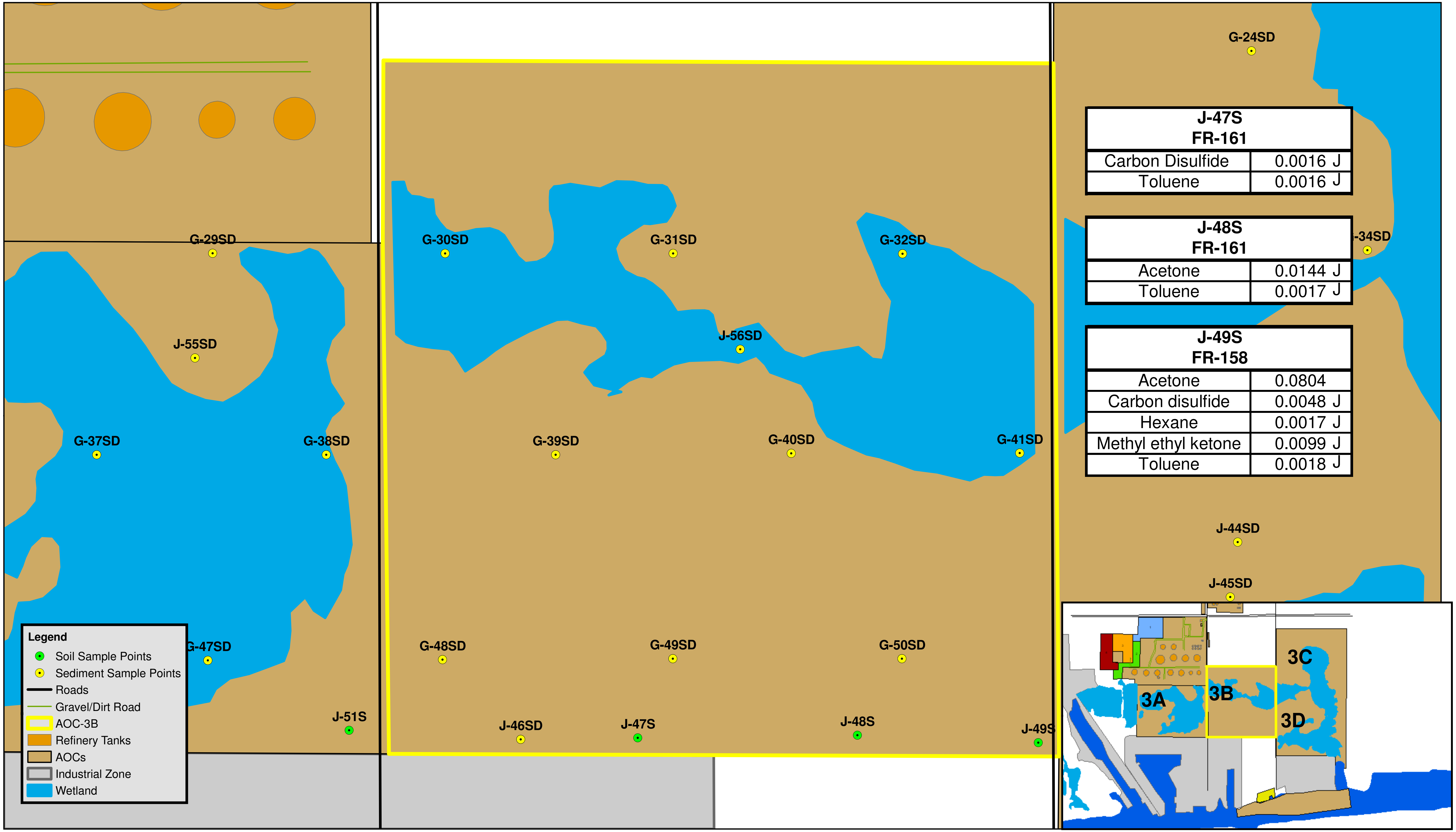
FIGURE
28D



Notes:

1. Results are posted in mg/kg

2. Qualifiers:

J = Concentration greater than the sample detection limit (SDL) but less than the method

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VOC Subsurface Soil Distribution Map

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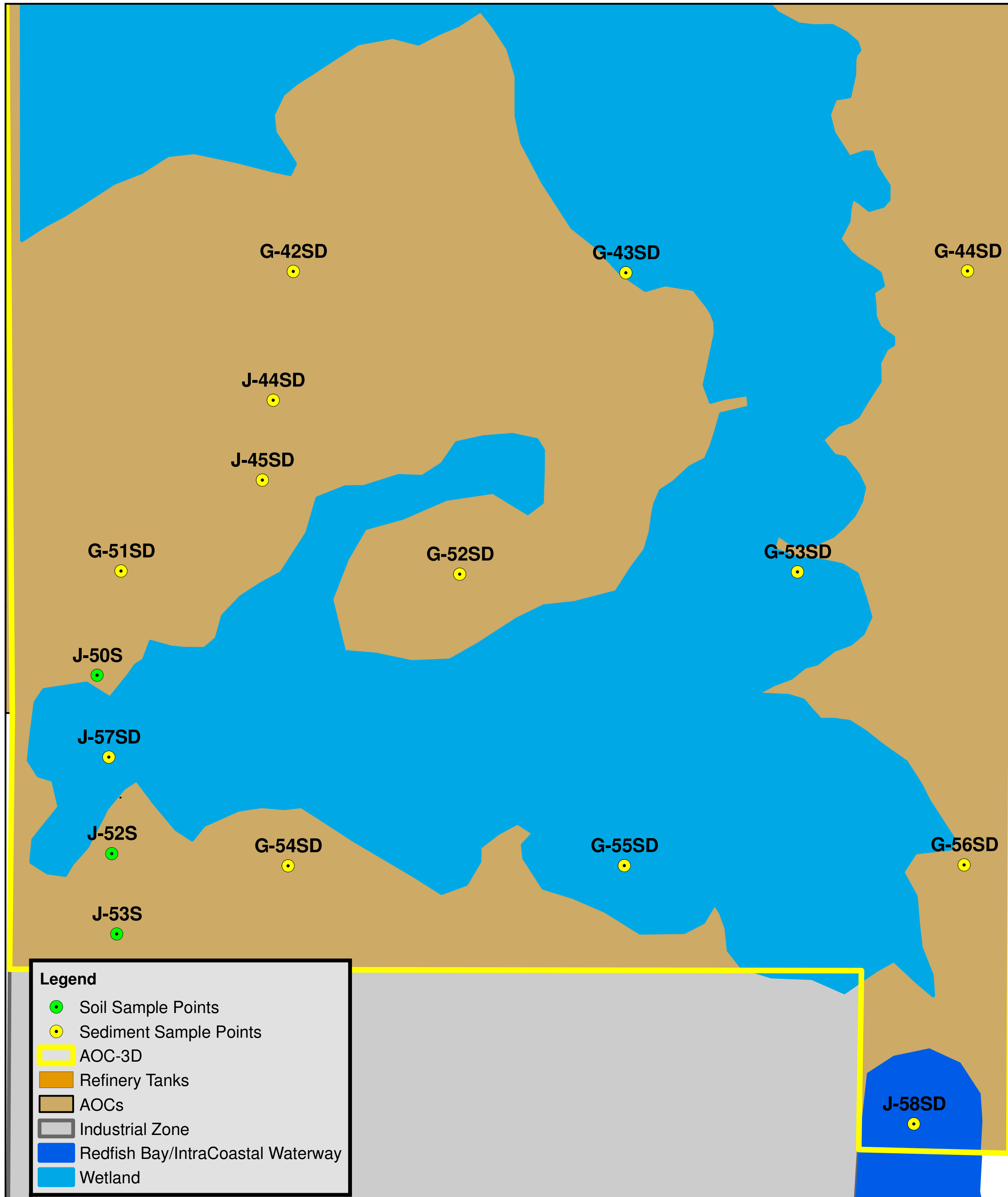
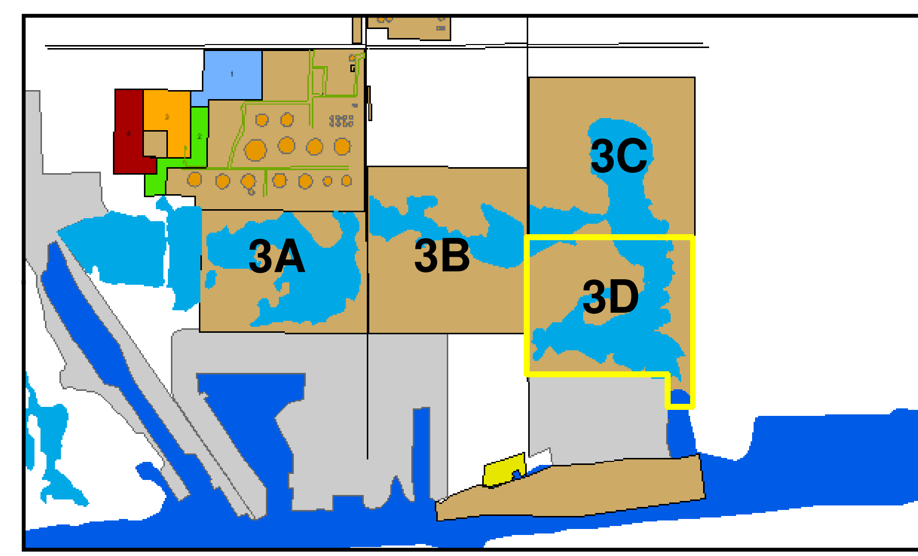
FIGURE
28E



J-50S FR-156	
Acetone	0.0164 J
Toluene	0.0017 J

J-52S FR-139	
Acetone	0.0165 J
Carbon disulfide	0.0023 J

J-53S FR-137	
Acetone	0.0094 J



Notes:

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0 100 200
Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON	
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APPROVED BY:	

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VOC Subsurface Soil Distribution Map

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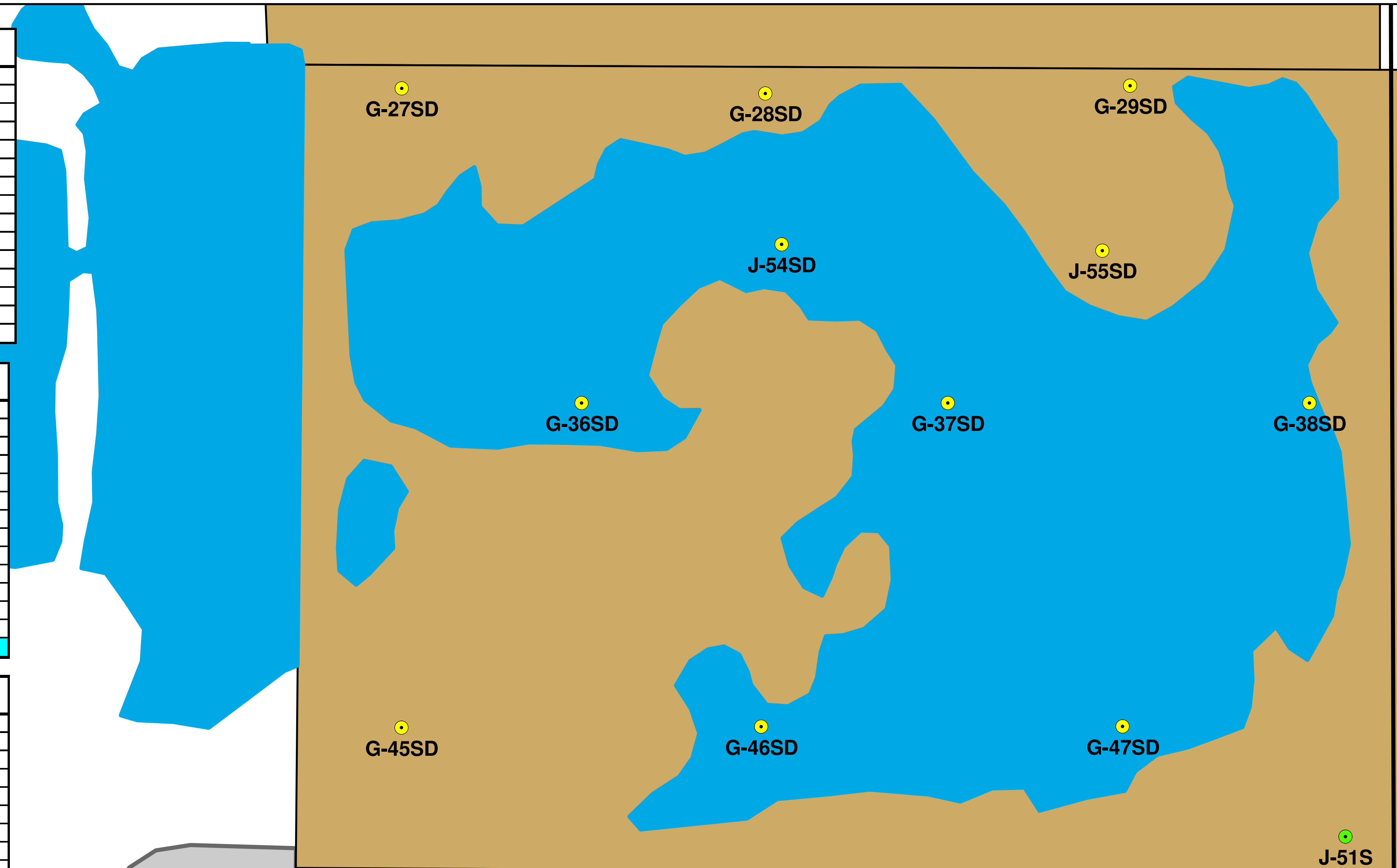
FIGURE
28F



G-27SD FR-141	
Aluminum	2390
Arsenic	1.6
Barium	514
Beryllium	0.11 B
Chromium	2.4
Cobalt	0.95 B
Copper	2.8
Iron	2260
Lead	4.2
Manganese	77
Nickel	1.3 B
Vanadium	6
Zinc	29.6

G-28SD FR-142A	
Aluminum	6165
Arsenic	1.6
Barium	118
Beryllium	0.225 B
Chromium	4.45
Cobalt	1.4 B
Copper	2.95
Iron	3990
Lead	6.7
Manganese	100.6
Mercury	0.00335 B
Nickel	2.45 B
Selenium	1.065
Vanadium	9.6
Zinc	32.25

G-29SD FR-144	
Aluminum	1490
Arsenic	1.7
Barium	63.9
Beryllium	0.064 B
Chromium	1.3
Cobalt	0.46 B
Copper	2.6 B
Iron	1190
Lead	2.4
Manganese	54.9
Nickel	0.83 B
Vanadium	3 B
Zinc	34.5

G-36SD FR-168	
Aluminum	11700
Arsenic	3.3
Barium	211
Beryllium	0.43 B
Chromium	9.2
Cobalt	2.8 B
Copper	7.7
Iron	7580
Lead	11.9
Manganese	352
Mercury	0.021 B
Nickel	5.4
Vanadium	16.1
Zinc	119

G-37SD FR-170	
Aluminum	10300
Arsenic	4.7
Barium	277
Beryllium	0.4 B
Chromium	9.4
Cobalt	2.5 B
Copper	8
Iron	6910
Lead	12.4
Manganese	270
Mercury	0.015 B
Nickel	4.9 B
Vanadium	16.8
Zinc	187

G-38SD FR-171	
Aluminum	5620
Arsenic	2.4
Barium	404
Beryllium	0.21 B
Chromium	5.7
Cobalt	1.4 B
Copper	4.2
Iron	3830
Lead	10.6
Manganese	177
Mercury	0.0085 B
Nickel	2.7 B
Selenium	0.34 B
Vanadium	8.3
Zinc	122

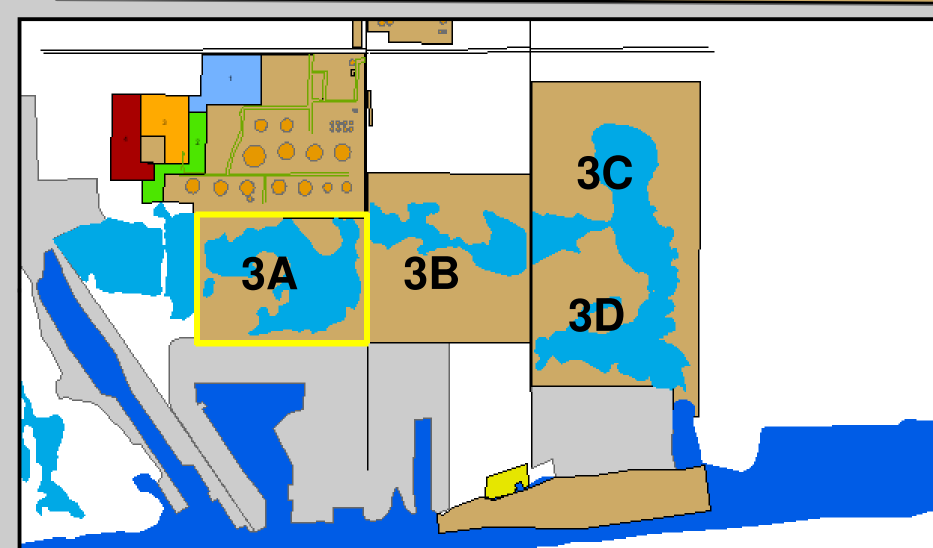
G-45SD FR-174	
Aluminum	4290
Arsenic	0.67 B
Barium	174
Beryllium	0.21 B
Chromium	4.2
Cobalt	1.3 B
Copper	4.1
Iron	3370
Lead	4.7
Manganese	49.4
Mercury	0.019
Nickel	2.1 B
Vanadium	6.2
Zinc	96.5

G-46SD FR-176	
Aluminum	23100
Arsenic	8.9
Barium	1100
Beryllium	0.97
Chromium	23.8
Cobalt	5.8 B
Copper	24.9
Iron	16000
Lead	34.1
Manganese	588
Mercury	0.033 B
Nickel	12.7
Vanadium	39.9
Zinc	896

G-47SD FR-173	
Aluminum	10400
Arsenic	2.6
Barium	343
Beryllium	0.42 B
Chromium	7.6
Hex Chrom	1.8 B
Cobalt	2.9 B
Copper	4.6
Iron	6960
Lead	9.5
Manganese	210
Mercury	0.015 B
Nickel	4.4 B
Vanadium	13.6
Zinc	64.1

J-54SD FR-150	
Aluminum	18900
Arsenic	5
Barium	332
Beryllium	0.68 B
Chromium	14.6
Cobalt	4.3 B
Copper	12.1
Iron	12000
Lead	17.9
Manganese	427
Mercury	0.034 B
Nickel	8 B
Vanadium	25.1
Zinc	208

J-55SD FR-152A	
Aluminum	4655
Arsenic	1.3
Barium	208.5
Beryllium	0.19 B
Chromium	4.2
Cobalt	1.15 B
Copper	3.25
Iron	3370
Lead	7.65
Manganese	72.3
Mercury	0.014 B
Nickel	2.05 B
Vanadium	6.6
Zinc	59.8



Legend

- Sediment Sample Points
- Soil Sample Points
- Roads
- AOCs
- Industrial Zone
- Redfish Bay/IntraCoastal Waterway
- Wetland

Notes:

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2. Qualifiers:

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Above Sediment Marine Limit

N

0 100 200
Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-3A
Ecological
Metal Sediment Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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FIGURE
29A

G-30SD FR-186	
Aluminum	2010
Arsenic	1.6
Barium	24.3
Beryllium	0.094 B
Chromium	1.9
Cobalt	0.52 B
Copper	1.3 B
Iron	1550
Lead	3.1
Manganese	59.8
Mercury	0.004 B
Nickel	1.1 B
Vanadium	4.1 B
Zinc	17.2

G-40SD FR-185	
Aluminum	953
Arsenic	0.75 B
Barium	29.2
Beryllium	0.056 B
Chromium	1.1 B
Cobalt	0.32 B
Copper	1.1 B
Iron	827
Lead	1.8
Manganese	17.9
Mercury	0.0037 B
Nickel	0.31 B
Vanadium	1.9 B
Zinc	27.5

G-50SD FR-182	
Aluminum	1180
Arsenic	0.31 B
Barium	25.8
Beryllium	0.058 B
Chromium	2
Cobalt	0.22 B
Copper	1.1 B
Iron	853
Lead	2.3
Manganese	14.1
Mercury	0.025
Nickel	1.4 B
Vanadium	1.6 B
Zinc	58.3

G-31SD FR-183	
Aluminum	1670
Arsenic	1.3
Barium	34.4
Beryllium	0.091 B
Chromium	1.6
Cobalt	0.81 B
Copper	1.1 B
Iron	2250
Lead	3.1
Manganese	75
Mercury	0.0034 B
Nickel	0.88 B
Vanadium	3 B
Zinc	16.9

G-41SD FR-189	
Aluminum	2860
Arsenic	1.5
Barium	68.4
Beryllium	0.13 B
Chromium	2.9
Cobalt	0.64 B
Copper	2.2 B
Iron	1980
Lead	7.5
Manganese	61.1
Mercury	0.011 B
Nickel	1.4 B
Vanadium	4.8 B
Zinc	37.8

J-46SD FR-178	
Aluminum	5590
Arsenic	1.1
Barium	308
Beryllium	0.23 B
Cadmium	0.12 B
Chromium	6.3
Cobalt	1.4 B
Copper	7.1
Iron	3900
Lead	9.3
Manganese	98.1
Mercury	0.018
Nickel	2.9 B
Selenium	0.28 B
Vanadium	8.2
Zinc	305

G-32SD FR-188	
Aluminum	2860
Arsenic	2.2
Barium	90.5
Beryllium	0.12 B
Cadmium	0.48 B
Chromium	2.9
Cobalt	0.74 B
Copper	2.5 B
Iron	2200
Lead	5.2
Manganese	142
Mercury	0.0068 B
Nickel	1.5 B
Silver	0.12 B
Vanadium	5.7
Zinc	52.3

G-48SD FR-179	
Aluminum	10900
Arsenic	2.3
Barium	471
Beryllium	0.47 B
Cadmium	0.41 B
Chromium	17.4
Cobalt	2.8 B
Copper	23
Iron	7830
Lead	29.1
Manganese	304
Mercury	0.032
Nickel	7.2
Selenium	1.2 B
Silver	0.24 B
Vanadium	16
Zinc	812

J-56SD FR-184	
Aluminum	2180
Arsenic	1.5
Barium	71.6
Beryllium	0.1 B
Chromium	2.1
Cobalt	0.55 B
Copper	1.5 B
Iron	1740
Lead	2
Manganese	55.3
Mercury	0.021
Nickel	1.2 B
Vanadium	3.8 B
Zinc	27

G-39SD FR-187	
Aluminum	2060
Arsenic	0.45 B
Barium	94
Beryllium	0.096 B
Chromium	2.2
Cobalt	0.34 B
Copper	2.1 B
Iron	1350
Lead	4
Manganese	9.5
Mercury	0.011 B
Nickel	0.67 B
Vanadium	3 B
Zinc	37.8

G-49SD FR-180A	
Aluminum	2330
Arsenic	0.79 B
Barium	1695
Beryllium	0.125 B
Cadmium	0.235 B
Chromium	2.7
Cobalt	1.025 B
Copper	2.5
Iron	1885
Lead	4
Manganese	54.25
Mercury	0.00725 B
Nickel	1.35 B
Vanadium	3.95 B
Zinc	24.7

Notes:

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Above Sediment Marine Limit

0 110 220
Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
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APPROVED BY:	

AOC-3B
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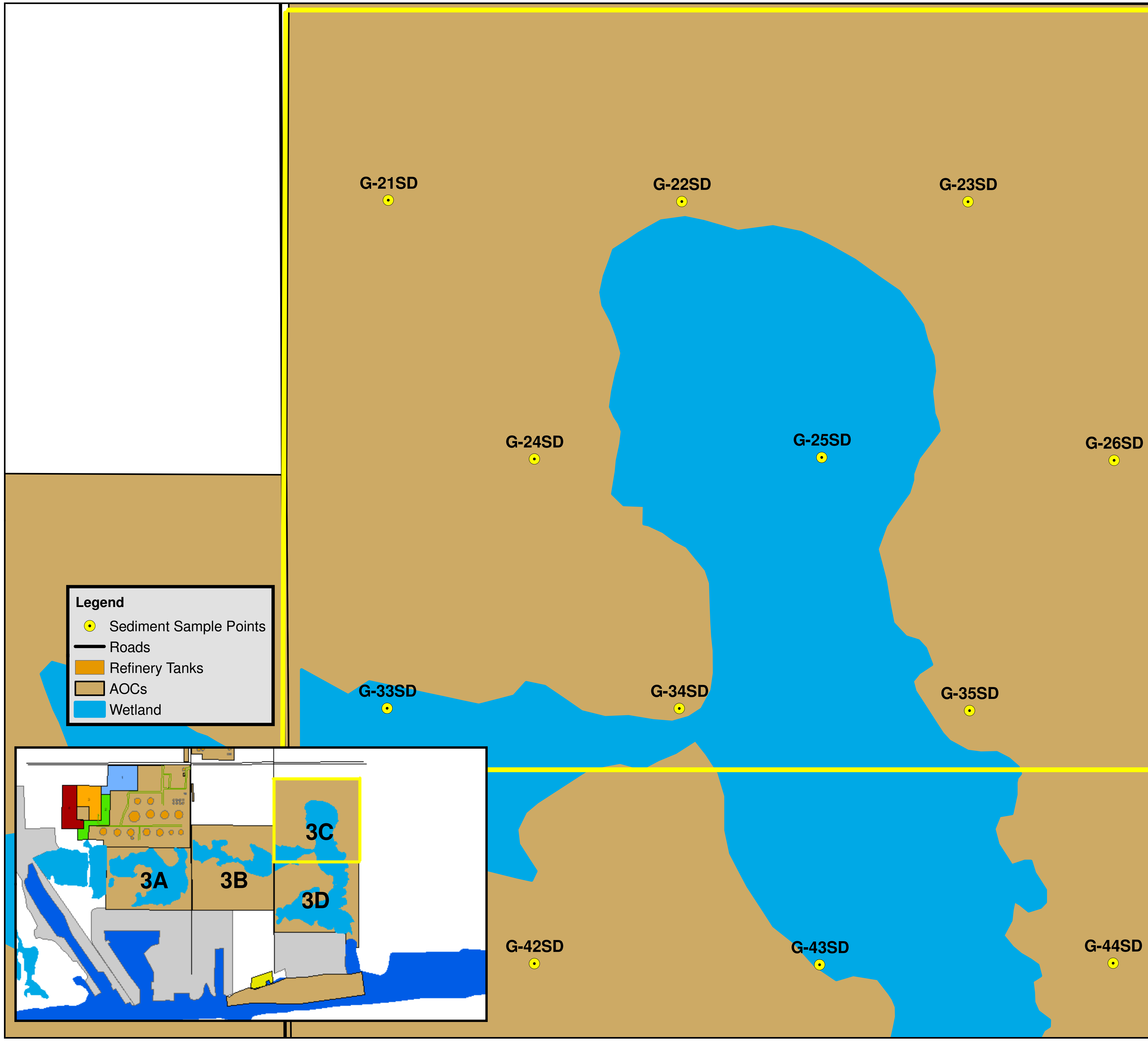
FIGURE
29B



G-21SD FR-210	
Aluminum	971
Arsenic	0.33 B
Barium	22.8
Beryllium	0.051 B
Chromium	1.2
Cobalt	0.2 B
Copper	1.1 B
Iron	676
Lead	9.1
Manganese	21.7
Mercury	0.0081 B
Nickel	0.72 B
Silver	0.093 B
Vanadium	1.2 B
Zinc	134

G-22SD FR-209	
Aluminum	34700
Arsenic	17.3
Barium	95.2 B
Beryllium	1.3 B
Cadmium	0.67 B
Chromium	29.9
Cobalt	10.4 B
Copper	57.1
Iron	23200
Lead	30.5
Manganese	171
Mercury	0.11
Nickel	23.5
Selenium	2.2 B
Silver	1.3 B
Vanadium	58.9
Zinc	611

G-23SD FR-208	
Aluminum	35900
Arsenic	6.3
Barium	310
Beryllium	1.4
Cadmium	0.32 B
Chromium	28.9
Cobalt	9
Copper	21.2
Iron	23700
Lead	18.1
Manganese	398
Mercury	0.046
Nickel	18.1
Selenium	1 B
Silver	1.1 B
Vanadium	48.2
Zinc	207

G-24SD FR-204	
Aluminum	2600
Arsenic	1.4
Barium	47.4
Beryllium	0.14 B
Chromium	2.4
Cobalt	1.1 B
Copper	3.3
Iron	2120
Lead	4.9
Manganese	79.6
Mercury	0.0021 B
Nickel	1.8 B
Vanadium	4.8 B
Zinc	53.4

G-25SD FR-205	
Aluminum	5490
Arsenic	2.4
Barium	45.1
Beryllium	0.22 B
Chromium	4.7
Cobalt	1.6 B
Copper	5.3
Iron	3870
Lead	6.2
Manganese	162
Mercury	0.0097 B
Nickel	3.1 B
Silver	0.27 B
Vanadium	8.5
Zinc	68.2

G-26SD FR-206A	
Aluminum	6525
Arsenic	2.13 B
Barium	133.15
Beryllium	0.2565 B
Cadmium	0.21 B
Chromium	7.55
Cobalt	1.72 B
Copper	15.85 B
Iron	5635
Lead	6.55
Manganese	240.85
Mercury	0.0072 B
Nickel	8.735 B
Selenium	0.445 B
Silver	0.175 B
Vanadium	10.25
Zinc	257.6

G-33SD FR-190	
Aluminum	3810
Arsenic	2.8
Barium	72.4
Beryllium	0.15 B
Chromium	3.5
Cobalt	0.93 B
Copper	4.4
Iron	2780
Lead	14
Manganese	95.9
Mercury	0.0071 B
Nickel	2.1 B
Vanadium	6.4
Zinc	91.2

G-34SD FR-191	
Aluminum	4560
Arsenic	0.86 B
Barium	7.8 B
Beryllium	0.19 B
Chromium	3.3
Cobalt	0.91 B
Copper	1.1 B
Iron	2880
Lead	2.5
Manganese	32.2
Mercury	0.0029 B
Nickel	1.3 B
Vanadium	5.1 B
Zinc	11.2

G-35SD FR-192	
Aluminum	2220
Arsenic	1.4
Barium	10.4 B
Beryllium	0.1 B
Chromium	2
Cobalt	0.57 B
Copper	1.9 B
Iron	1490
Lead	3.9
Manganese	91.5
Mercury	0.0051 B
Nickel	1.1 B
Silver	0.11 B
Vanadium	3.6 B
Zinc	40

Notes:

1. Results are posted in mg/kg

2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Above Sediment Marine Limit

N

0 100 200

Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-3C
Ecological
Metal Sediment Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

KLEINFELDER
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www.kleinfelder.com

FIGURE

29C

G-42SD FR-198	
Aluminum	1080
Arsenic	0.43 B
Barium	23.1
Beryllium	0.055 B
Chromium	1.2
Cobalt	0.27 B
Copper	1.5 B
Iron	842
Lead	3.1
Manganese	16.4
Mercury	0.0019 B
Nickel	0.47 B
Vanadium	1.5 B
Zinc	26.7

G-43SD FR-199	
Aluminum	13400
Arsenic	6.3
Barium	176
Beryllium	0.52 B
Cadmium	0.25 B
Chromium	13.6
Cobalt	3.1 B
Copper	19.3
Iron	9650
Lead	14.1
Manganese	483
Mercury	0.022 B
Nickel	9.4
Selenium	0.47 B
Silver	0.32 B
Vanadium	19.8
Zinc	463

G-44SD FR-200	
Aluminum	1790
Arsenic	1.7
Barium	48.4
Beryllium	0.1 B
Chromium	2.4
Cobalt	0.67 B
Copper	2.5 B
Iron	1810
Lead	2.1
Manganese	47.7
Nickel	1.7 B
Vanadium	3.6 B
Zinc	88.2

G-51SD FR-193A	
Aluminum	2060
Arsenic	0.625 B
Barium	88.95
Beryllium	0.0965 B
Chromium	2.35
Cobalt	0.42 B
Copper	3.3
Iron	1480
Lead	4.9
Manganese	34.65
Mercury	0.015 B
Nickel	1.3 B
Vanadium	2.65 B
Zinc	92.5

G-52SD FR-195	
Aluminum	1900
Arsenic	0.75 B
Barium	47.8
Beryllium	0.098 B
Chromium	2.3
Cobalt	0.56 B
Copper	1.9 B
Iron	1580
Lead	3.1
Manganese	61.6
Mercury	0.0051 B
Nickel	1.1 B
Vanadium	3.5 B
Zinc	95.9

G-53SD FR-196	
Aluminum	5000
Arsenic	1.5
Barium	66.2
Beryllium	0.21 B
Chromium	4.5
Cobalt	1.4 B
Copper	3.6
Iron	3440
Lead	5.4
Manganese	168
Mercury	0.018 B
Nickel	2.7 B
Vanadium	6.7
Zinc	104

G-54SD FR-213	
Aluminum	2870
Arsenic	2.8
Barium	67.1
Beryllium	0.15 B
Chromium	3.3
Cobalt	0.62 B
Copper	2.9
Iron	2460
Lead	4.7
Manganese	72.7
Mercury	0.029
Nickel	2.4 B
Vanadium	6.1
Zinc	128

G-55SD FR-215	
Aluminum	12300
Arsenic	4.8
Barium	62.5
Beryllium	0.49 B
Cadmium	0.2 B
Chromium	11.8
Hex Chrom	7.3
Cobalt	3.2 B
Copper	20.7
Iron	8200
Lead	13.5
Manganese	97.3
Mercury	0.027 B
Nickel	8.6
Silver	0.15 B
Vanadium	18.8
Zinc	569

G-56SD FR-216	
Aluminum	2750
Arsenic	1.4
Barium	78.5
Beryllium	0.14 B
Chromium	3.3
Cobalt	0.79 B
Copper	2.8
Iron	2270
Lead	8.1
Manganese	60
Mercury	0.0034 B
Nickel	2.1 B
Selenium	0.34 B
Vanadium	5.4
Zinc	86.4

J-44SD FR-201A	
Aluminum	1205
Arsenic	0.455 B
Barium	36.8
Beryllium	0.0061 B
Chromium	1.35
Cobalt	0.235
Copper	1.8 B
Iron	857
Lead	3.55
Manganese	20.15
Mercury	0.015 B
Nickel	0.515 B
Vanadium	1.65 B
Zinc	42.45

J-45SD FR-203	
Aluminum	1960
Arsenic	0.74 B
Barium	80.9
Beryllium	0.092 B
Chromium	2.4
Cobalt	0.56 B
Copper	2.1 B
Iron	1540
Lead	4.7
Manganese	58.9
Mercury	0.0061 B
Nickel	1.4 B
Silver	0.089 B
Vanadium	2.5 B
Zinc	91.4

J-57SD FR-212	
Aluminum	14500
Arsenic	6.5
Barium	134
Beryllium	0.58 B
Cadmium	0.33 B
Chromium	14.9
Hex Chrom	1.4 B
Cobalt	4.1 B
Copper	32.2
Iron	11000
Lead	17.9
Manganese	504
Mercury	0.031
Nickel	11.4
Selenium	0.39 B
Silver	0.24 B
Vanadium	20.7
Zinc	802

J-58SD FR-218	
Aluminum	2240
Arsenic	0.86 B
Barium	22.8 B
Beryllium	0.11 B
Chromium	2.5
Cobalt	0.67 B
Copper	3.5
Iron	2190
Lead	2.5
Manganese	65.1
Mercury	0.0047 B
Nickel	1.6 B
Selenium	0.31 B
Vanadium	3.8 B
Zinc	96

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Above Sediment Marine Limit

N

0 100 200
Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-3D
Ecological
Metal Sediment Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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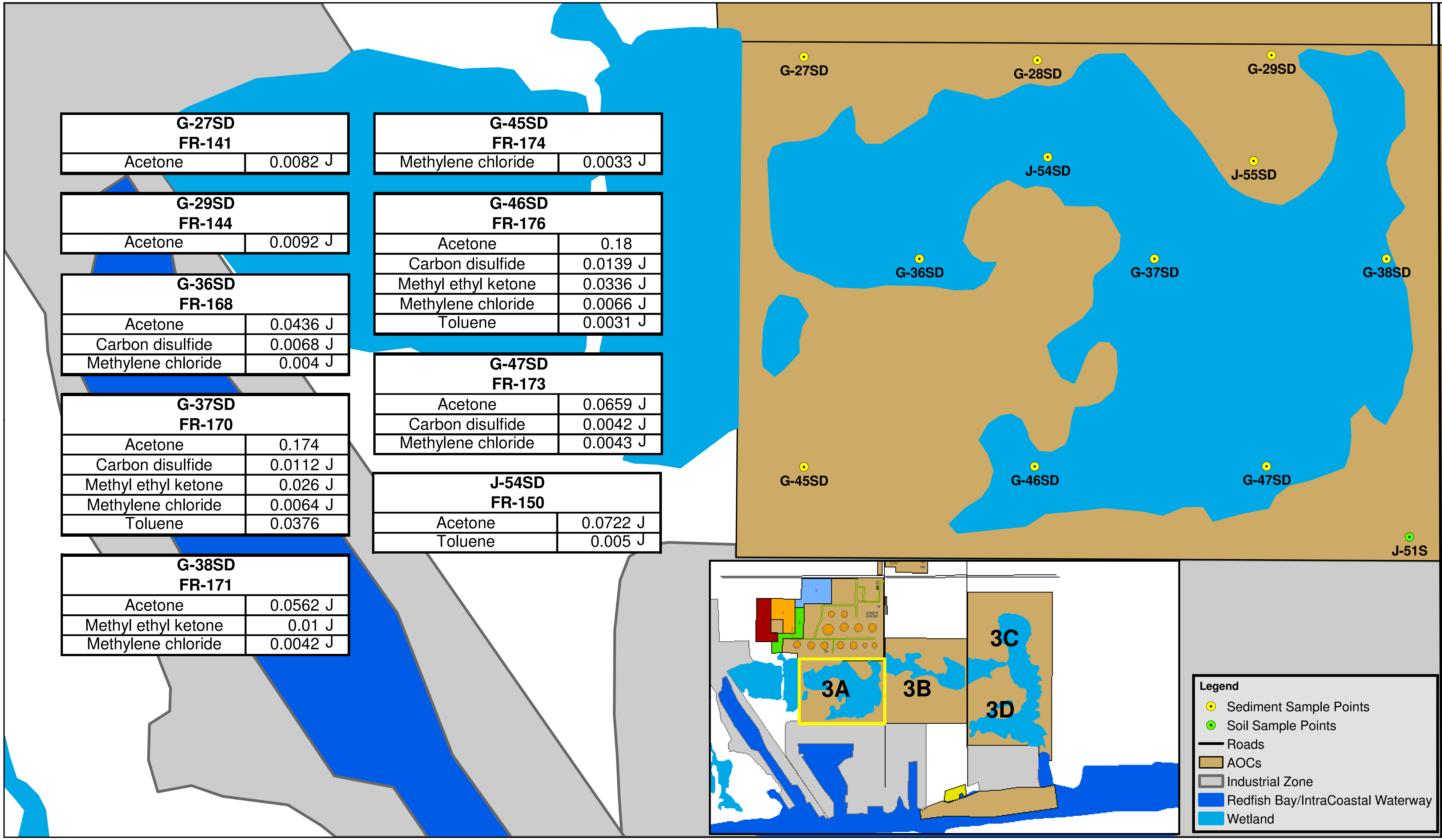
FIGURE
29D



G-27SD FR-141	
Acetone	0.0082 J

G-29SD FR-144	
Acetone	0.0092 J

G-36SD FR-168	
Acetone	0.0436 J
Carbon disulfide	0.0068 J
Methylene chloride	0.004 J

G-37SD FR-170	
Acetone	0.174
Carbon disulfide	0.0112 J
Methyl ethyl ketone	0.026 J
Methylene chloride	0.0064 J
Toluene	0.0376

G-38SD FR-171	
Acetone	0.0562 J
Methyl ethyl ketone	0.01 J
Methylene chloride	0.0042 J

G-45SD FR-174	
Methylene chloride	0.0033 J

G-46SD FR-176	
Acetone	0.18
Carbon disulfide	0.0139 J
Methyl ethyl ketone	0.0336 J
Methylene chloride	0.0066 J
Toluene	0.0031 J

G-47SD FR-173	
Acetone	0.0659 J
Carbon disulfide	0.0042 J
Methylene chloride	0.0043 J

J-54SD FR-150	
Acetone	0.0722 J
Toluene	0.005 J

Notes:

1. Results are posted in mg/kg

2. Qualifiers:

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

N

0 100 200

Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-3A
Ecological
VOC Sediment Distribution Map

FALCON REFINERY
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PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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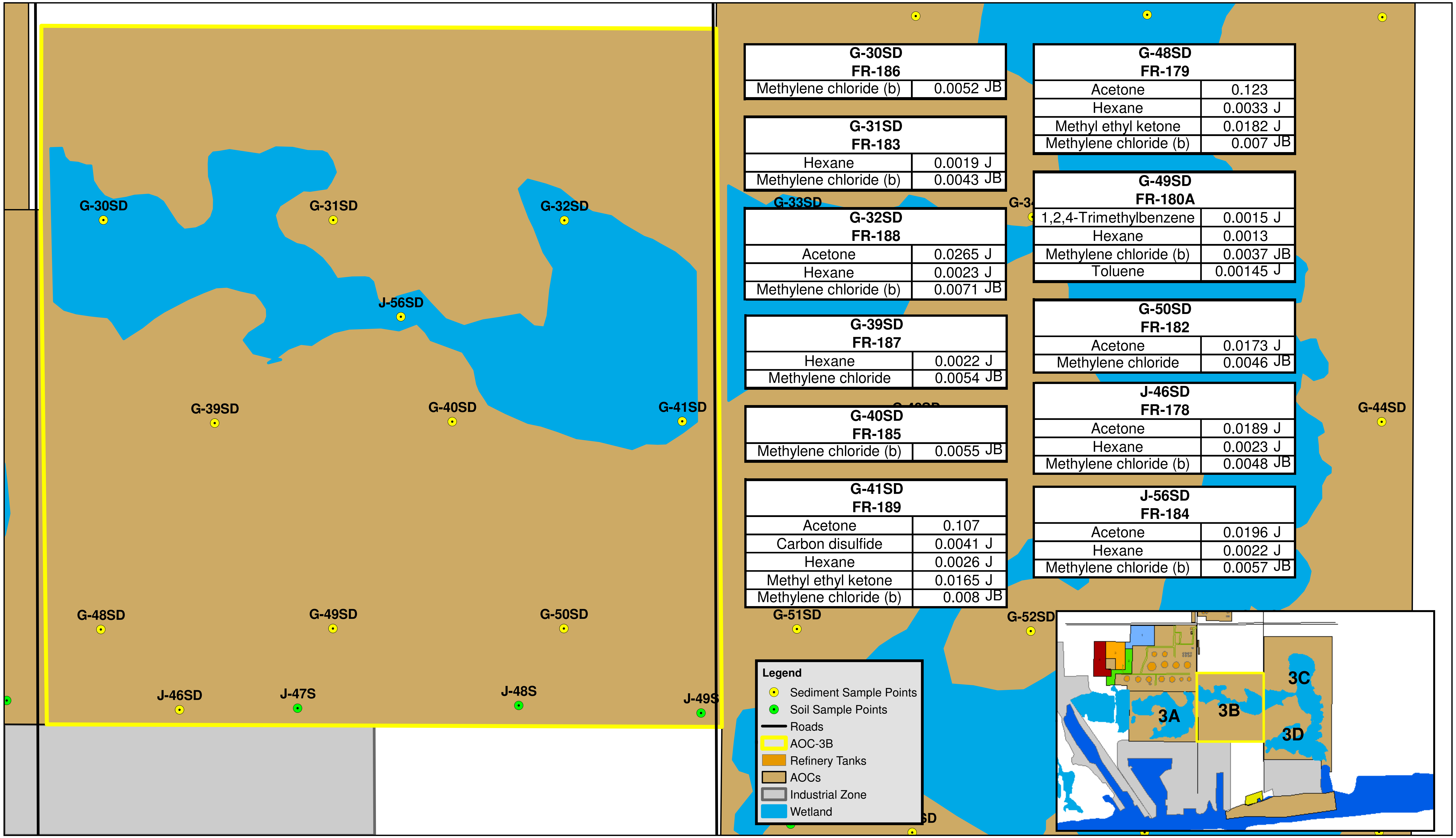
FIGURE
29E



G-30SD FR-186	
Methylene chloride (b)	0.0052 JB

G-31SD FR-183	
Hexane	0.0019 J
Methylene chloride (b)	0.0043 JB

G-32SD FR-188	
Acetone	0.0265 J
Hexane	0.0023 J
Methylene chloride (b)	0.0071 JB

G-39SD FR-187	
Hexane	0.0022 J
Methylene chloride	0.0054 JB

G-40SD FR-185	
Methylene chloride (b)	0.0055 JB

G-41SD FR-189	
Acetone	0.107
Carbon disulfide	0.0041 J
Hexane	0.0026 J
Methyl ethyl ketone	0.0165 J
Methylene chloride (b)	0.008 JB

G-48SD FR-179	
Acetone	0.123
Hexane	0.0033 J
Methyl ethyl ketone	0.0182 J
Methylene chloride (b)	0.007 JB

G-49SD FR-180A	
1,2,4-Trimethylbenzene	0.0015 J
Hexane	0.0013
Methylene chloride (b)	0.0037 JB
Toluene	0.00145 J

G-50SD FR-182	
Acetone	0.0173 J
Methylene chloride	0.0046 JB

J-46SD FR-178	
Acetone	0.0189 J
Hexane	0.0023 J
Methylene chloride (b)	0.0048 JB

J-56SD FR-184	
Acetone	0.0196 J
Hexane	0.0022 J
Methylene chloride (b)	0.0057 JB

Notes:

1. Results are posted in mg/kg
2. Qualifiers:
   J = Concentration greater than the SDL but less than the method quantitation limit (MQL)
   B = Analyte found in associated method blank

N

0 100 200

Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
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APPROVED BY:	

AOC-3B
Ecological
VOC Sediment Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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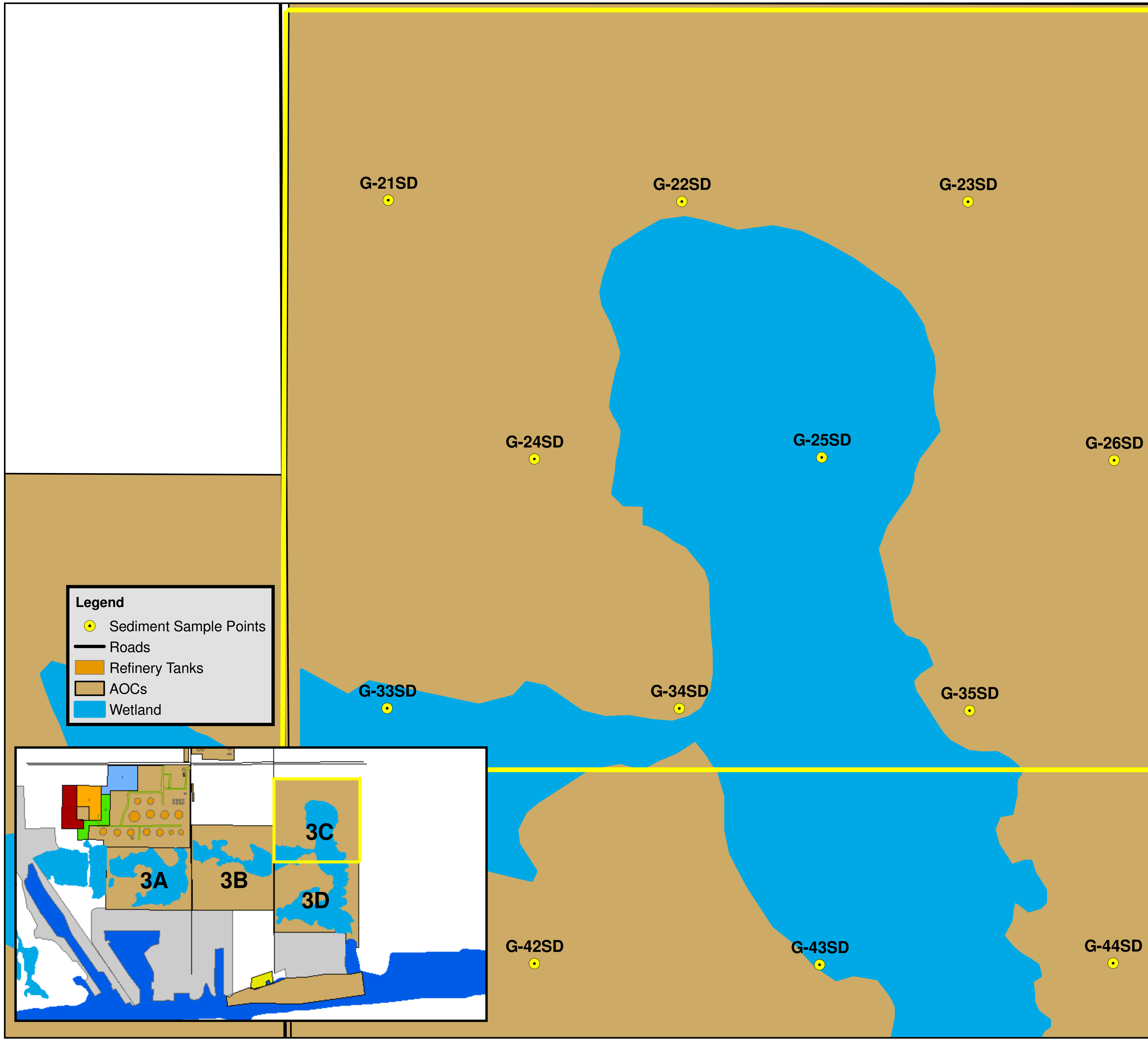
FIGURE

29F



G-21SD FR-210	
Acetone	0.048 J
Methylene chloride (b)	0.0038 JB

G-22SD FR-209	
Acetone	0.668
Carbon disulfide	0.0241 J
Hexane	0.0086 J
Naphthalene	0.21 U
Methyl ethyl ketone	0.135 J
Methylene chloride (b)	0.0199 JB

G-23SD FR-208	
Methylene chloride (b)	0.0079 JB

G-24SD FR-204	
Methylene chloride	0.0058 J

G-25SD FR-205	
Acetone	0.0135 J
Methylene chloride	0.0037 J

G-26SD FR-206A	
Methylene chloride	0.0057 J

G-33SD FR-190	
Acetone	0.151
Carbon disulfide	0.0029 J
Hexane	0.0026 J
Methyl ethyl ketone	0.029 J
Methylene chloride (b)	0.0063 JB

G-34SD FR-191	
Methylene chloride (b)	0.0059 JB

G-35SD FR-192	
Methylene chloride (b)	0.0064 JB

Notes:

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   - B = Analyte found in associated method blank

Exceeds Sediment Marine Screening Level

N

0 100 200

Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-3C Ecological VOC Sediment Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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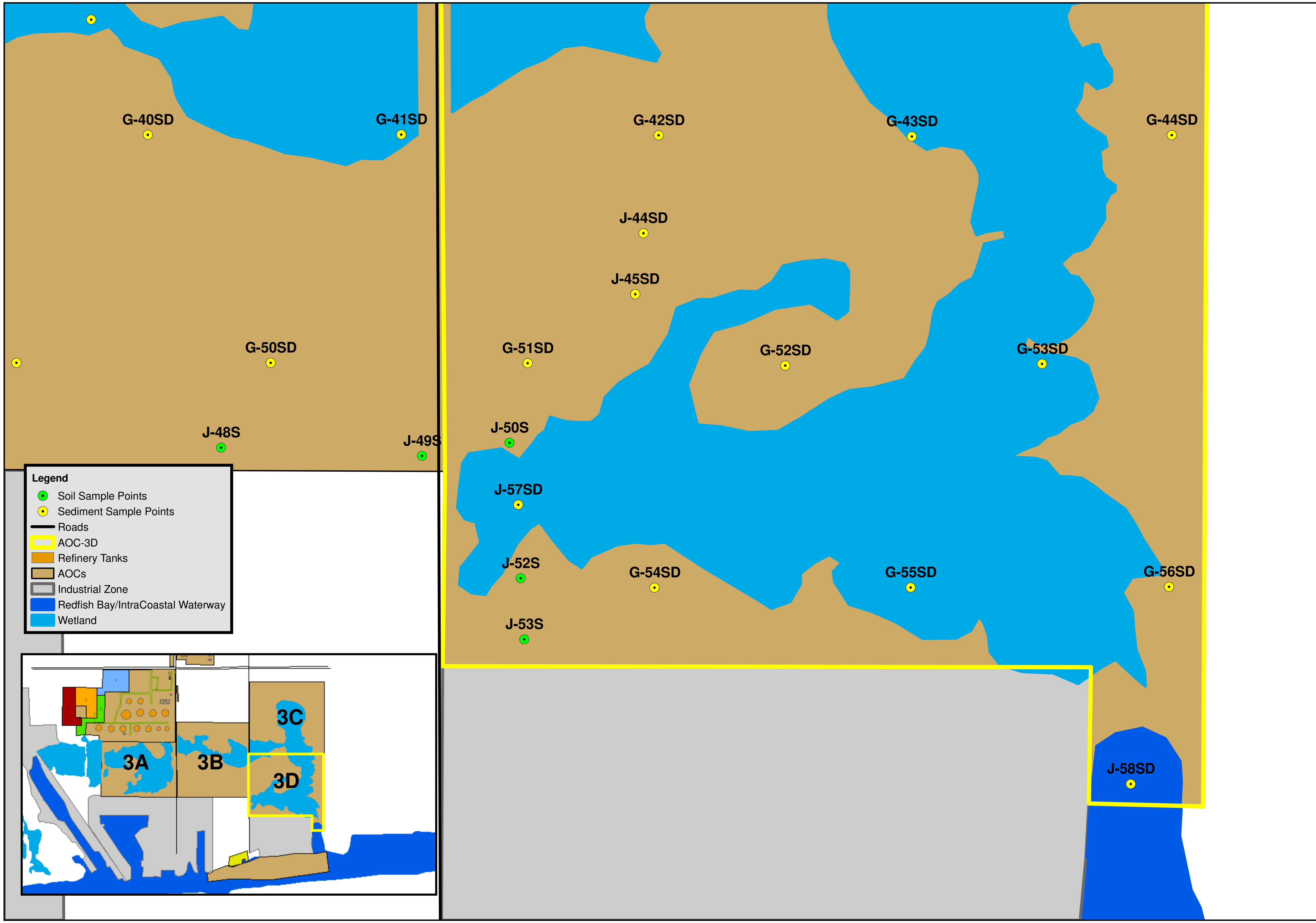
FIGURE
29G



G-42SD FR-198	
1,2,4-Trimethylbenzene	0.0014 J
Acetone	0.0336 J

G-43SD FR-199	
Acetone	0.0698 J
Hexane	0.0063 J
Methyl ethyl ketone	0.0154 J
Methylene chloride	0.0043 J

G-44SD FR-200	
1,2,4-Trimethylbenzene	0.0045 J
Ethylbenzene	0.0015 J
Methylene chloride	0.0048 J
Toluene	0.0027 J
Xylene (total)	0.0061 J

G-51SD FR-193A	
1,2,4-Trimethylbenzene	0.0049
Acetone	0.0492
Benzene	0.0016 J
Ethylbenzene	0.00305 J
Isopropylbenzene	0.0015 J
Methylene chloride	0.0057 J
n-Propylbenzene	0.0024 J
Toluene	0.00415
Xylene (total)	0.0099 J

G-52SD FR-196	
Methylene chloride	0.005 JB

G-53SD FR-196	
Acetone	0.0111 J
Methylene chloride (b)	0.0058 JB

G-54SD FR-213	
1,2,4-Trimethylbenzene	0.0018 J
Methylene chloride	0.0055 J
Toluene	0.0022 J

G-55SD FR-215	
Acetone	0.128
Carbon disulfide	0.009 J
Methyl ethyl ketone	0.0255 J
Methylene chloride (b)	0.0069 JB

G-56SD FR-216	
Methylene chloride (b)	0.0042 JB

J-44SD FR-201A	
Acetone	0.088
Methylene chloride	0.00295

J-45SD FR-203	
Acetone	0.0112 J
Methylene chloride	0.0047 J

J-57SD FR-212	
Acetone	0.15
Carbon disulfide	0.0048 J
Methyl ethyl ketone	0.0264 J
Methylene chloride (b)	0.0057 JB

J-58SD FR-218	
Acetone	0.0499 J
Carbon disulfide	0.0032 J
Methyl ethyl ketone (b)	0.0119 JB
Methylene chloride	0.0036 J

Notes:

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2. Qualifiers:

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

B = Analyte found in associated method blank

N

0 100 200

Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-3D
Ecological
VOC Sediment Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 | FILE NAME: Falcon Refinery Base Map

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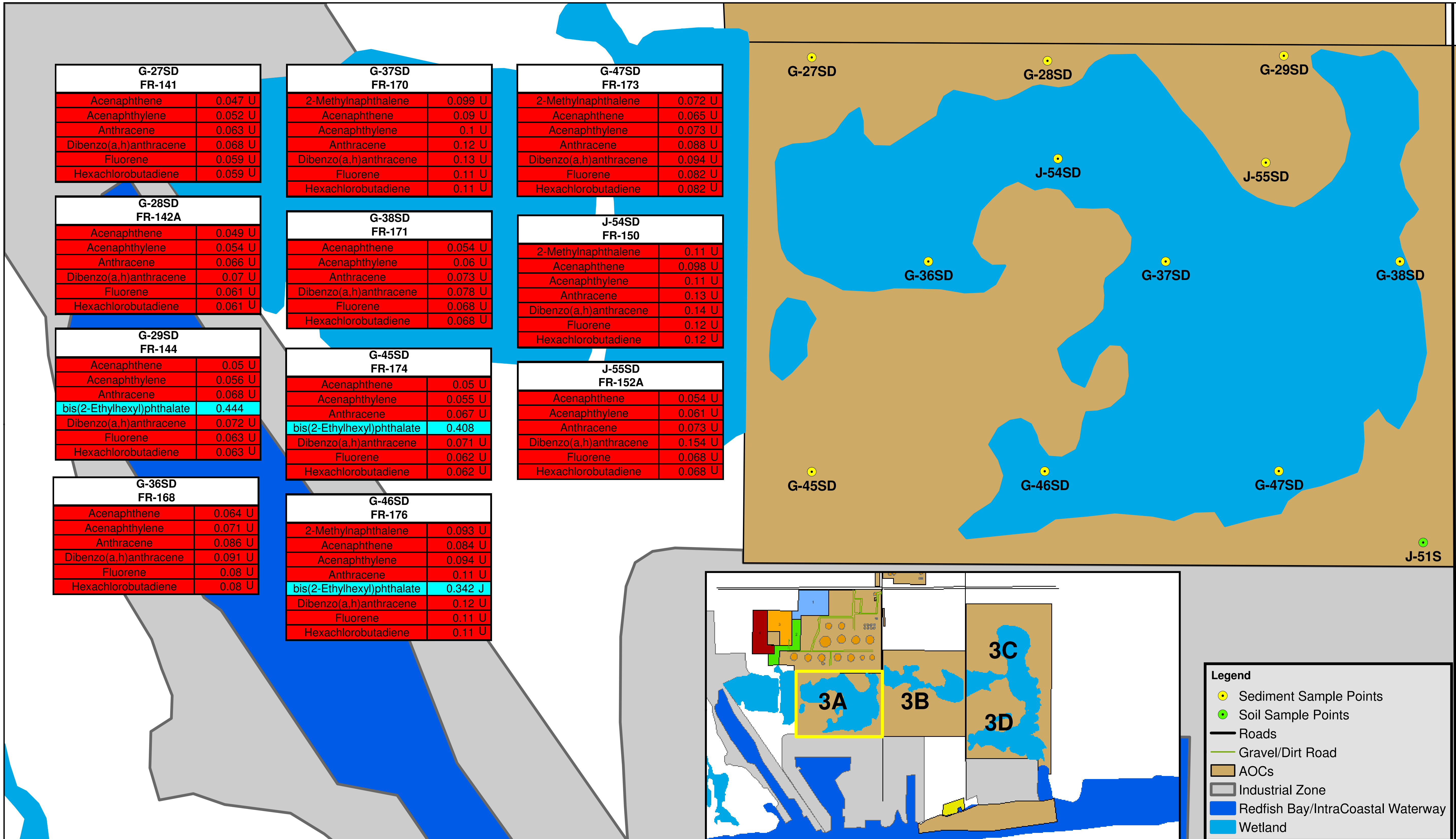
FIGURE
29H



G-27SD FR-141	
Acenaphthene	0.047 U
Acenaphthylene	0.052 U
Anthracene	0.063 U
Dibenzo(a,h)anthracene	0.068 U
Fluorene	0.059 U
Hexachlorobutadiene	0.059 U

G-28SD FR-142A	
Acenaphthene	0.049 U
Acenaphthylene	0.054 U
Anthracene	0.066 U
Dibenzo(a,h)anthracene	0.07 U
Fluorene	0.061 U
Hexachlorobutadiene	0.061 U

G-29SD FR-144	
Acenaphthene	0.05 U
Acenaphthylene	0.056 U
Anthracene	0.068 U
bis(2-Ethylhexyl)phthalate	0.444
Dibenzo(a,h)anthracene	0.072 U
Fluorene	0.063 U
Hexachlorobutadiene	0.063 U

G-36SD FR-168	
Acenaphthene	0.064 U
Acenaphthylene	0.071 U
Anthracene	0.086 U
Dibenzo(a,h)anthracene	0.091 U
Fluorene	0.08 U
Hexachlorobutadiene	0.08 U

G-37SD FR-170	
2-Methylnaphthalene	0.099 U
Acenaphthene	0.09 U
Acenaphthylene	0.1 U
Anthracene	0.12 U
Dibenzo(a,h)anthracene	0.13 U
Fluorene	0.11 U
Hexachlorobutadiene	0.11 U

G-38SD FR-171	
Acenaphthene	0.054 U
Acenaphthylene	0.06 U
Anthracene	0.073 U
Dibenzo(a,h)anthracene	0.078 U
Fluorene	0.068 U
Hexachlorobutadiene	0.068 U

G-45SD FR-174	
Acenaphthene	0.05 U
Acenaphthylene	0.055 U
Anthracene	0.067 U
bis(2-Ethylhexyl)phthalate	0.408
Dibenzo(a,h)anthracene	0.071 U
Fluorene	0.062 U
Hexachlorobutadiene	0.062 U

G-46SD FR-176	
2-Methylnaphthalene	0.093 U
Acenaphthene	0.084 U
Acenaphthylene	0.094 U
Anthracene	0.11 U
bis(2-Ethylhexyl)phthalate	0.342 J
Dibenzo(a,h)anthracene	0.12 U
Fluorene	0.11 U
Hexachlorobutadiene	0.11 U

G-47SD FR-173	
2-Methylnaphthalene	0.072 U
Acenaphthene	0.065 U
Acenaphthylene	0.073 U
Anthracene	0.088 U
Dibenzo(a,h)anthracene	0.094 U
Fluorene	0.082 U
Hexachlorobutadiene	0.082 U

J-54SD FR-150	
2-Methylnaphthalene	0.11 U
Acenaphthene	0.098 U
Acenaphthylene	0.11 U
Anthracene	0.13 U
Dibenzo(a,h)anthracene	0.14 U
Fluorene	0.12 U
Hexachlorobutadiene	0.12 U

J-55SD FR-152A	
Acenaphthene	0.054 U
Acenaphthylene	0.061 U
Anthracene	0.073 U
Dibenzo(a,h)anthracene	0.154 U
Fluorene	0.068 U
Hexachlorobutadiene	0.068 U

Notes:

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   - J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

Above Sediment Marine Limit

Exceeds Sediment Marine Screening Level

N

0 110 220

Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-3A
Ecological
SVOC Sediment Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 | FILE NAME: Falcon Refinery Base Map

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FIGURE
29I

G-30SD FR-186	
Acenaphthene	0.047 U
Acenaphthylene	0.053 U
Anthracene	0.064 U
Dibenzo(a,h)anthracene	0.068 U
Fluorene	0.059 U
Hexachlorobutadiene	0.059 U

G-31SD FR-183	
Acenaphthene	0.047 U
Acenaphthylene	0.052 U
Anthracene	0.063 U
Dibenzo(a,h)anthracene	0.067 U
Fluorene	0.059 U
Hexachlorobutadiene	0.059 U

G-32SD FR-188	
Acenaphthene	0.052 U
Acenaphthylene	0.058 U
Anthracene	0.07 U
Dibenzo(a,h)anthracene	0.075 U
Fluorene	0.065 U
Hexachlorobutadiene	0.065 U

G-39SD FR-187	
Acenaphthene	0.052 U
Acenaphthylene	0.059 U
Anthracene	0.071 U
Dibenzo(a,h)anthracene	0.075 U
Fluorene	0.066 U
Hexachlorobutadiene	0.066 U

G-40SD FR-185	
Acenaphthene	0.047 U
Acenaphthylene	0.052 U
Anthracene	0.063 U
Dibenzo(a,h)anthracene	0.068 U
Fluorene	0.059 U
Hexachlorobutadiene	0.059 U

G-41SD FR-189	
Acenaphthene	0.058 U
Acenaphthylene	0.064 U
Anthracene	0.077 U
Dibenzo(a,h)anthracene	0.083 U
Fluorene	0.072 U
Hexachlorobutadiene	0.072 U

G-48SD FR-179	
2-Methylnaphthalene	0.072 U
Acenaphthene	0.065 U
Acenaphthylene	0.073 U
Anthracene	0.088 U
Dibenzo(a,h)anthracene	0.094 U
Fluorene	0.082 U
Hexachlorobutadiene	0.082 U

G-49SD FR-180A	
Acenaphthene	0.046 U
Acenaphthylene	0.051 U
Anthracene	0.062 U
Dibenzo(a,h)anthracene	0.066 U
Fluorene	0.058 U
Hexachlorobutadiene	0.058 U

G-50SD FR-182	
Acenaphthene	0.045 U
Acenaphthylene	0.05 U
Anthracene	0.061 U
Dibenzo(a,h)anthracene	0.065 U
Fluorene	0.057 U
Hexachlorobutadiene	0.057 U

J-46SD FR-178	
Acenaphthene	0.05 U
Acenaphthylene	0.056 U
Anthracene	0.068 U
Dibenzo(a,h)anthracene	0.073 U
Fluorene	0.063 U
Hexachlorobutadiene	0.063 U

J-56SD FR-184	
Acenaphthene	0.049 U
Acenaphthylene	0.055 U
Anthracene	0.066 U
Dibenzo(a,h)anthracene	0.071 U
Fluorene	0.062 U
Hexachlorobutadiene	0.062 U

Notes:

1. Results are posted in mg/kg

2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

Exceeds Sediment Marine Screening Level

0 100 200

Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-3B Ecological SVOC Sediment Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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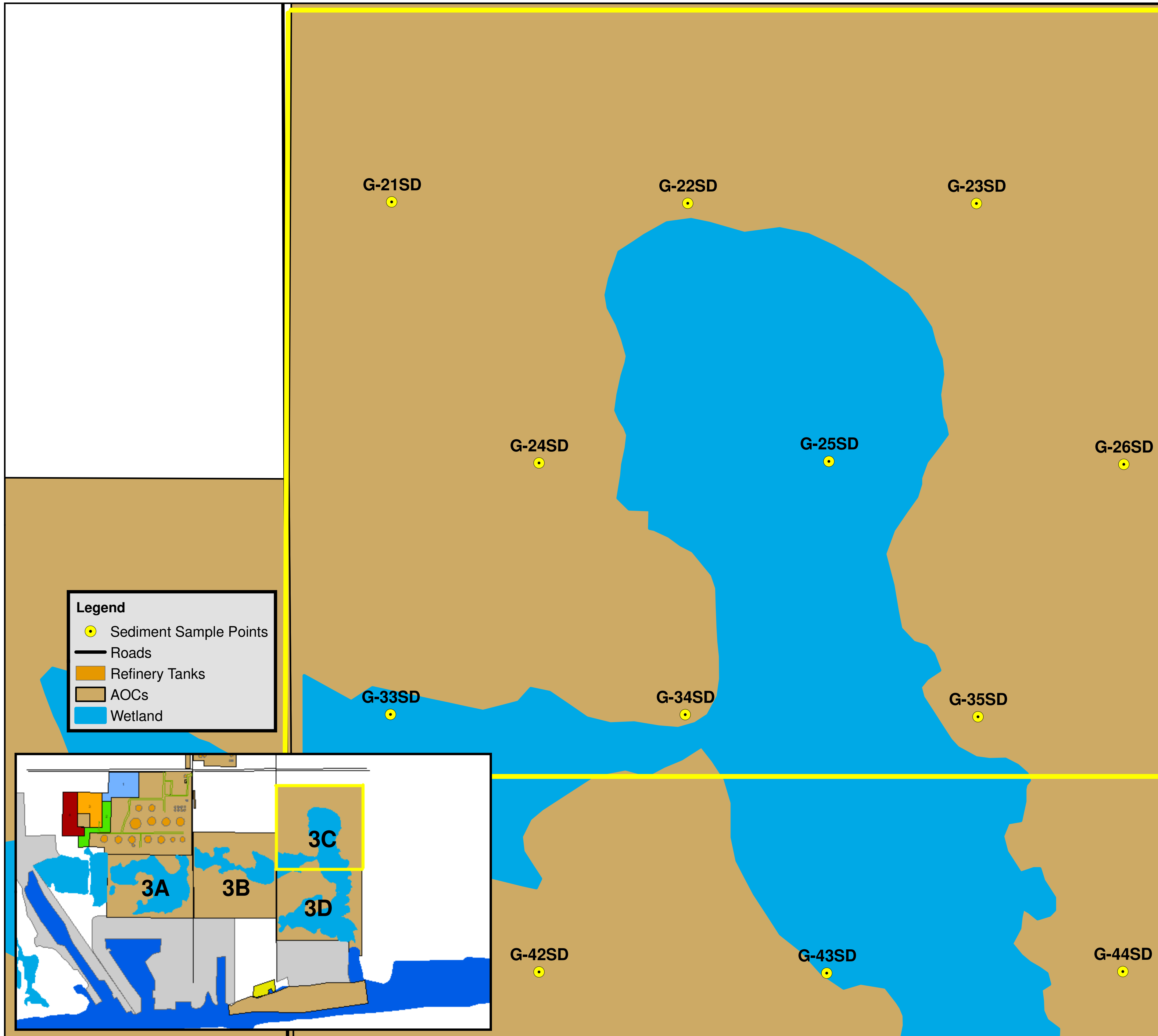
FIGURE

29J



G-21SD FR-210	
Acenaphthene	0.045 U
Acenaphthylene	0.05 U
Anthracene	0.061 U
bis(2-Ethylhexyl)phthalate	0.153 J
Dibenzo(a,h)anthracene	0.065 U
Fluorene	0.056 U
Hexachlorobutadiene	0.056 U

G-22SD FR-209	
2-Methylnaphthalene	0.23 U
Acenaphthene	0.21 U
Acenaphthylene	0.23 U
Anthracene	0.28 U
Benzo(a)anthracene	0.32 U
bis(2-Ethylhexyl)phthalate	0.43 U
Dibenzo(a,h)anthracene	0.3 U
Fluorene	0.26 U
Hexachlorobutadiene	0.26 U
Hexachloroethane	0.26 U

G-23SD FR-208	
2-Methylnaphthalene	0.082 U
Acenaphthene	0.074 U
Acenaphthylene	0.083 U
Anthracene	0.1 U
Dibenzo(a,h)anthracene	0.11 U
Fluorene	0.093 U
Hexachlorobutadiene	0.093 U

G-24SD FR-204	
Acenaphthene	0.05 U
Acenaphthylene	0.056 U
Anthracene	0.067 U
Dibenzo(a,h)anthracene	0.072 U
Fluorene	0.063 U
Hexachlorobutadiene	0.063 U

G-25SD FR-205	
Acenaphthene	0.058 U
Acenaphthylene	0.065 U
Anthracene	0.079 U
Dibenzo(a,h)anthracene	0.084 U
Fluorene	0.073 U
Hexachlorobutadiene	0.073 U

G-26SD FR-206A	
Acenaphthene	0.052 U
Acenaphthylene	0.058 U
Anthracene	0.07 U
Dibenzo(a,h)anthracene	0.075 U
Fluorene	0.065 U
Hexachlorobutadiene	0.065 U

G-33SD FR-190	
Acenaphthene	0.054 U
Acenaphthylene	0.06 U
Anthracene	0.072 U
Dibenzo(a,h)anthracene	0.077 U
Fluorene	0.067 U
Hexachlorobutadiene	0.067 U

G-34SD FR-191	
Acenaphthene	0.048 U
Acenaphthylene	0.054 U
Anthracene	0.065 U
Dibenzo(a,h)anthracene	0.07 U
Fluorene	0.061 U
Hexachlorobutadiene	0.061 U

G-35SD FR-192	
Acenaphthene	0.048 U
Acenaphthylene	0.054 U
Anthracene	0.065 U
Dibenzo(a,h)anthracene	0.07 U
Fluorene	0.061 U
Hexachlorobutadiene	0.061 U

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

Exceeds Sediment Marine Screening Level

N

0 100 200

Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-3C
Ecological
SVOC Sediment Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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FIGURE
29K

G-42SD FR-198	
Acenaphthene	0.045 U
Acenaphthylene	0.05 U
Anthracene	0.06 U
Dibenzo(a,h)anthracene	0.064 U
Fluorene	0.056 U
Hexachlorobutadiene	0.056 U

G-43SD FR-199	
2-Methylnaphthalene	0.079 U
Acenaphthene	0.071 U
Acenaphthylene	0.08 U
Anthracene	0.096 U
bis(2-Ethylhexyl)phthalate	0.729
Dibenzo(a,h)anthracene	0.1 U
Fluorene	0.09 U
Hexachlorobutadiene	0.09 U

G-44SD FR-200	
Acenaphthene	0.051 U
Acenaphthylene	0.057 U
Anthracene	0.069 U
Dibenzo(a,h)anthracene	0.073 U
Fluorene	0.064 U
Hexachlorobutadiene	0.064 U

G-51SD FR-193A	
Acenaphthene	0.049 U
Acenaphthylene	0.055 U
Anthracene	0.066 U
bis(2-Ethylhexyl)phthalate	0.136
Dibenzo(a,h)anthracene	0.071 U
Fluorene	0.061 U
Hexachlorobutadiene	0.061 U

G-52SD FR-195	
Acenaphthene	0.046 U
Acenaphthylene	0.051 U
Anthracene	0.062 U
Dibenzo(a,h)anthracene	0.066 U
Fluorene	0.058 U
Hexachlorobutadiene	0.058 U

G-53SD FR-196	
Acenaphthene	0.051 U
Acenaphthylene	0.057 U
Anthracene	0.069 U
Dibenzo(a,h)anthracene	0.074 U
Fluorene	0.064 U
Hexachlorobutadiene	0.064 U
Fluoranthene	0.0998 J

G-54SD FR-213	
Acenaphthene	0.052 U
Acenaphthylene	0.058 U
Anthracene	0.07 U
Dibenzo(a,h)anthracene	0.075 U
Fluorene	0.065 U
Hexachlorobutadiene	0.065 U

G-55SD FR-215	
2-Methylnaphthalene	0.09 U
Acenaphthene	0.082 U
Acenaphthylene	0.091 U
Anthracene	0.11 U
Dibenzo(a,h)anthracene	0.12 U
Fluorene	0.1 U
Hexachlorobutadiene	0.1 U

G-56SD FR-216	
Acenaphthene	0.048 U
Acenaphthylene	0.054 U
Anthracene	0.065 U
Dibenzo(a,h)anthracene	0.069 U
Fluorene	0.06 U
Hexachlorobutadiene	0.06 U

J-44SD FR-201A	
Acenaphthene	0.047 U
Acenaphthylene	0.053 U
Anthracene	0.063 U
Dibenzo(a,h)anthracene	0.067 U
Fluorene	0.059 U
Hexachlorobutadiene	0.059 U

J-45SD FR-203	
Acenaphthene	0.048 U
Acenaphthylene	0.053 U
Anthracene	0.064 U
Dibenzo(a,h)anthracene	0.069 U
Fluorene	0.06 U
Hexachlorobutadiene	0.06 U

J-57SD FR-212	
Acenaphthene	0.064 U
Acenaphthylene	0.071 U
Anthracene	0.086 U
Dibenzo(a,h)anthracene	0.092 U
Fluorene	0.08 U
Hexachlorobutadiene	0.08 U

J-58SD FR-218	
Acenaphthene	0.054 U
Acenaphthylene	0.06 U
Anthracene	0.072 U
Dibenzo(a,h)anthracene	0.077 U
Fluorene	0.067 U
Hexachlorobutadiene	0.067 U

Notes:

1. Results are posted in mg/kg

2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

Above Sediment Marine Limit

Exceeds Sediment Marine Screening Level

0 90 180

Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-3D Ecological SVOC Sediment Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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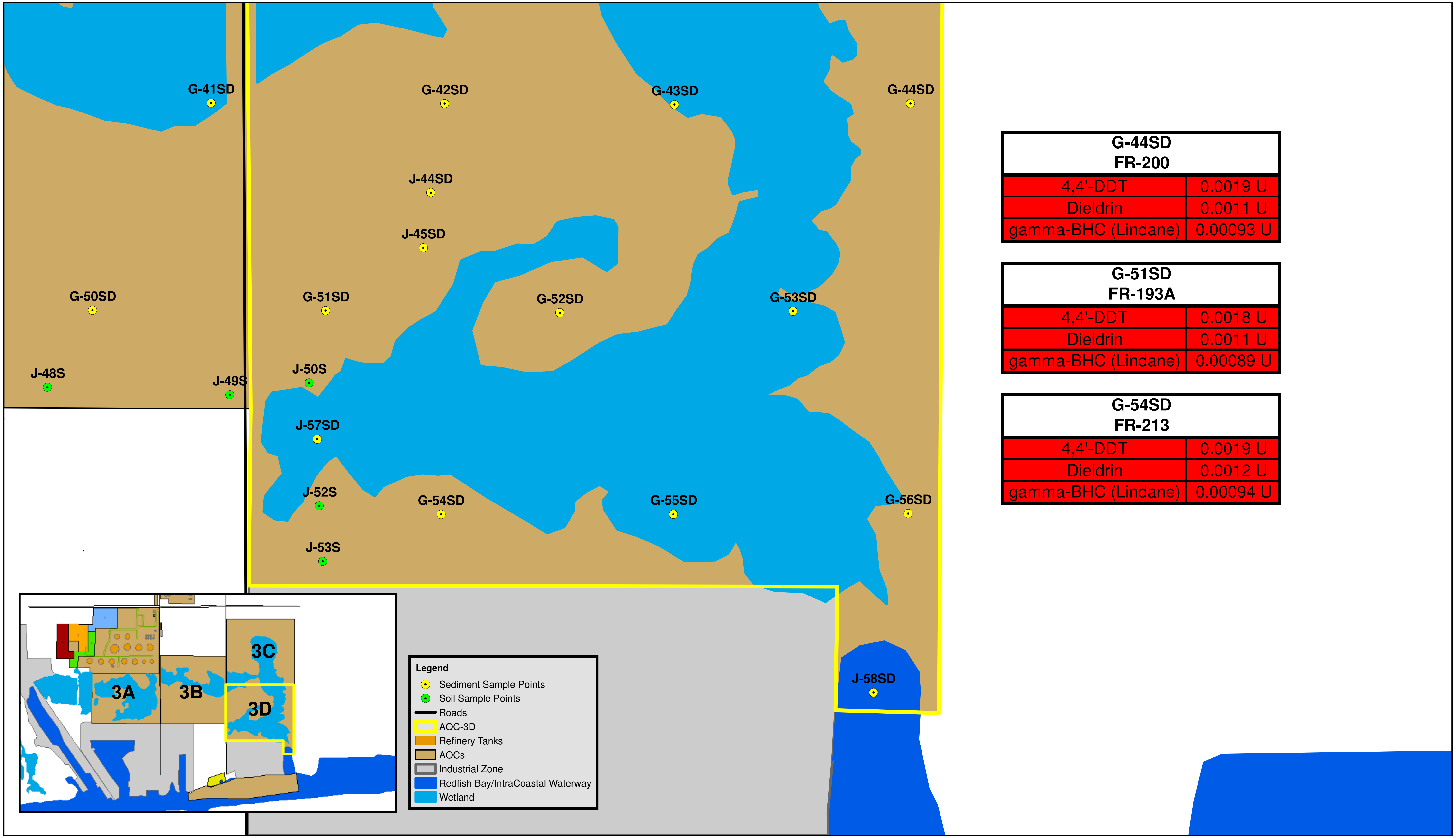
FIGURE

29L



G-44SD FR-200	
4,4'-DDT	0.0019 U
Dieldrin	0.0011 U
gamma-BHC (Lindane)	0.00093 U

G-51SD FR-193A	
4,4'-DDT	0.0018 U
Dieldrin	0.0011 U
gamma-BHC (Lindane)	0.00089 U

G-54SD FR-213	
4,4'-DDT	0.0019 U
Dieldrin	0.0012 U
gamma-BHC (Lindane)	0.00094 U

Notes:

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2. Qualifiers:
   U = Undetected at the sample detection limit (SDL)

Exceeds Sediment Marine Screening Level

N

0 100 200
Feet

DATE DRAWN: 7/8/08	DATE REVISED: 4/1/09
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-3D
Ecological
Pesticide Sediment Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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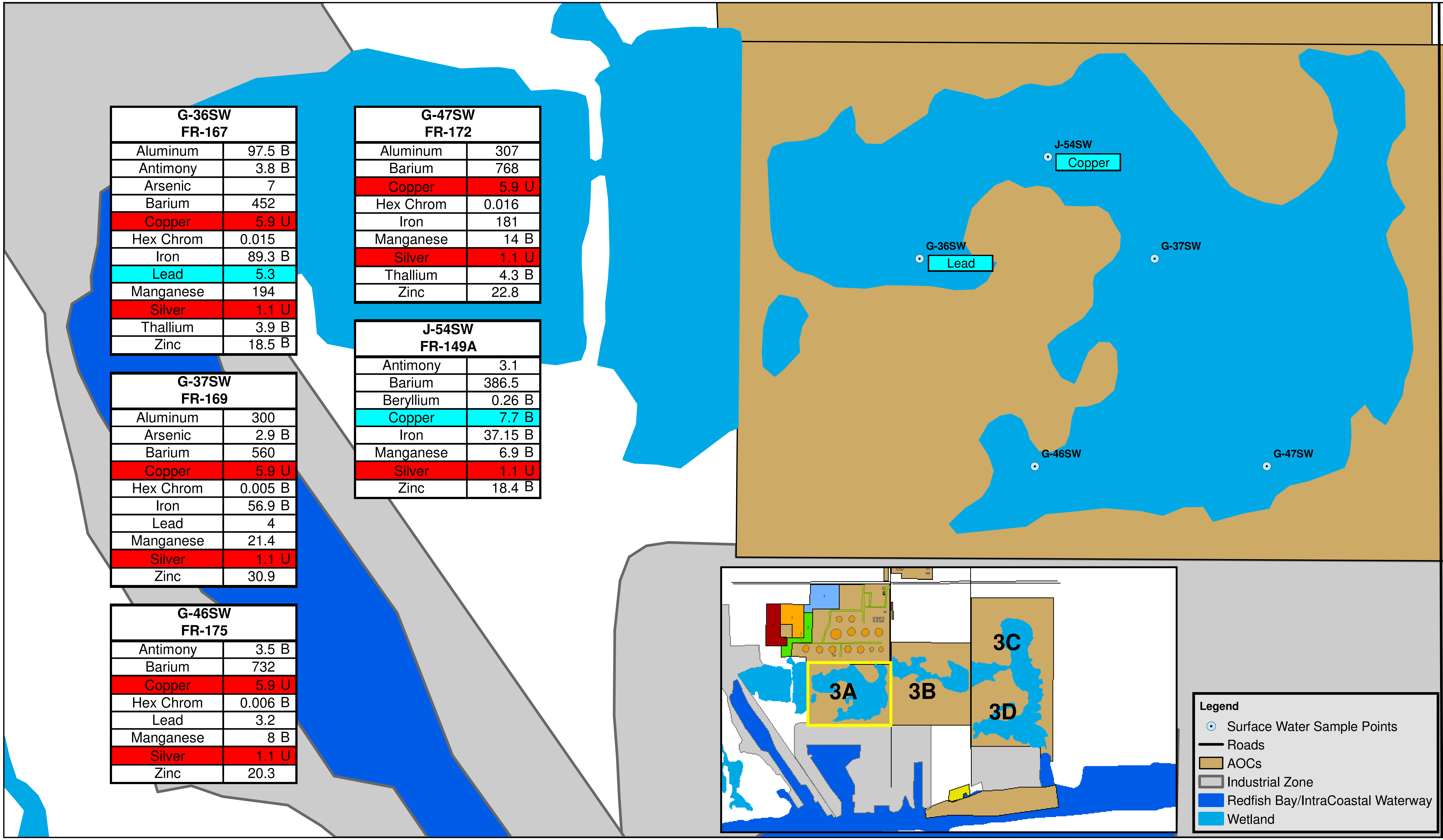
FIGURE
29M



G-36SW FR-167	
Aluminum	97.5 B
Antimony	3.8 B
Arsenic	7
Barium	452
Copper	5.9 U
Hex Chrom	0.015
Iron	89.3 B
Lead	5.3
Manganese	194
Silver	1.1 U
Thallium	3.9 B
Zinc	18.5 B

G-47SW FR-172	
Aluminum	307
Barium	768
Copper	5.9 U
Hex Chrom	0.016
Iron	181
Manganese	14 B
Silver	1.1 U
Thallium	4.3 B
Zinc	22.8

J-54SW FR-149A	
Antimony	3.1
Barium	386.5
Beryllium	0.26 B
Copper	7.7 B
Iron	37.15 B
Manganese	6.9 B
Silver	1.1 U
Zinc	18.4 B

G-37SW FR-169	
Aluminum	300
Arsenic	2.9 B
Barium	560
Copper	5.9 U
Hex Chrom	0.005 B
Iron	56.9 B
Lead	4
Manganese	21.4
Silver	1.1 U
Zinc	30.9

G-46SW FR-175	
Antimony	3.5 B
Barium	732
Copper	5.9 U
Hex Chrom	0.006 B
Lead	3.2
Manganese	8 B
Silver	1.1 U
Zinc	20.3

Notes:

1. Results are posted in µg/l
2. Qualifiers:
   - U = Undetected at the sample detection limit (SDL)
   - B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Above Marine Limit

Exceeds Marine Screening Level

N

0 100 200

Feet

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APPROVED BY:	

AOC-3A
Ecological
Metal Surface Water Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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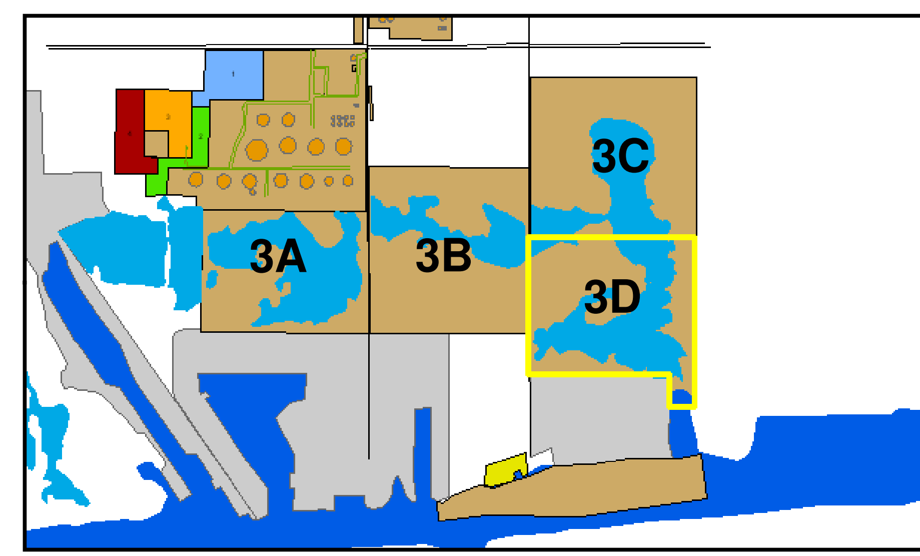
FIGURE
30A

J-57SW FR-211	
Aluminum	699
Antimony	4.1 B
Arsenic	10.6
Barium	393
Copper	5.9 U
Iron	576
Lead	4.8
Manganese	151
Nickel	3.7 B
Silver	1.1 U
Vanadium	5.1 B
Zinc	75.8

J-58SW FR-217	
Aluminum	128 B
Antimony	4.2 B
Barium	49.1 B
Copper	5.9 U
Iron	104
Lead	10.2
Manganese	14.5 B
Silver	1.1 U
Thallium	9.2 B
Vanadium	1.6 B
Zinc	21.7



Notes:

1. Results are posted in µg/l
2. Qualifiers:
   - U = Undetected at the sample detection limit (SDL)
   - B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Above Marine Limit

Exceeds Marine Screening Level

0 110 220

Feet

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CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-3D
Ecological
Metal Surface Water Soil Distribution Map

FALCON REFINERY
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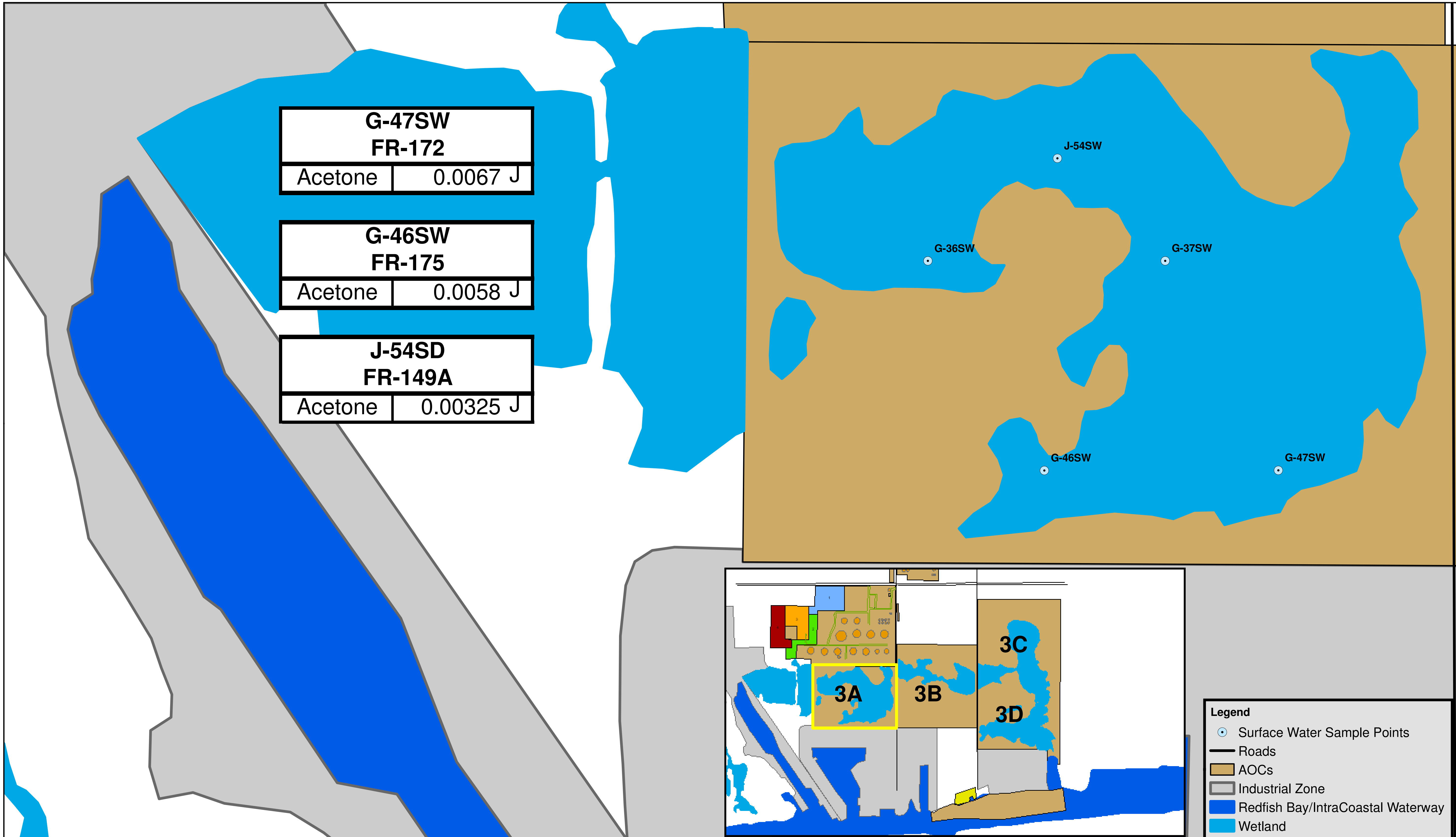
FIGURE
30B



Notes:

1. Results are posted in mg/l

2. Qualifiers:

J = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

0 100 200

Feet

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APPROVED BY:	

AOC-3A
Ecological
VOC Surface Water Distribution Map

FALCON REFINERY
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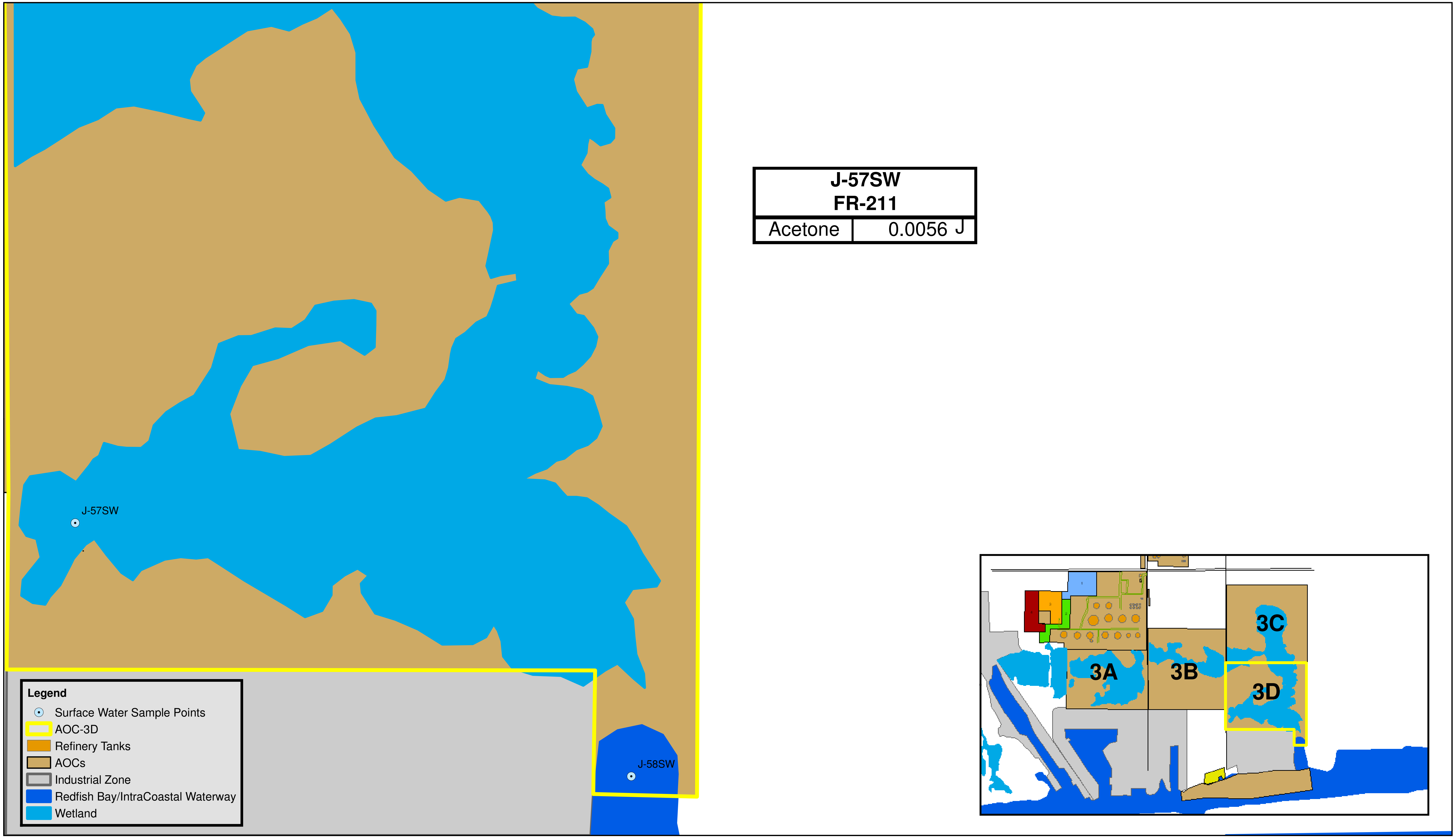
FIGURE
30C



Notes:

1. Results are posted in mg/l

2. Qualifiers:

J = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

N

0 100 200
Feet

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APPROVED BY:	

AOC-3D
Ecological
VOC Surface Water Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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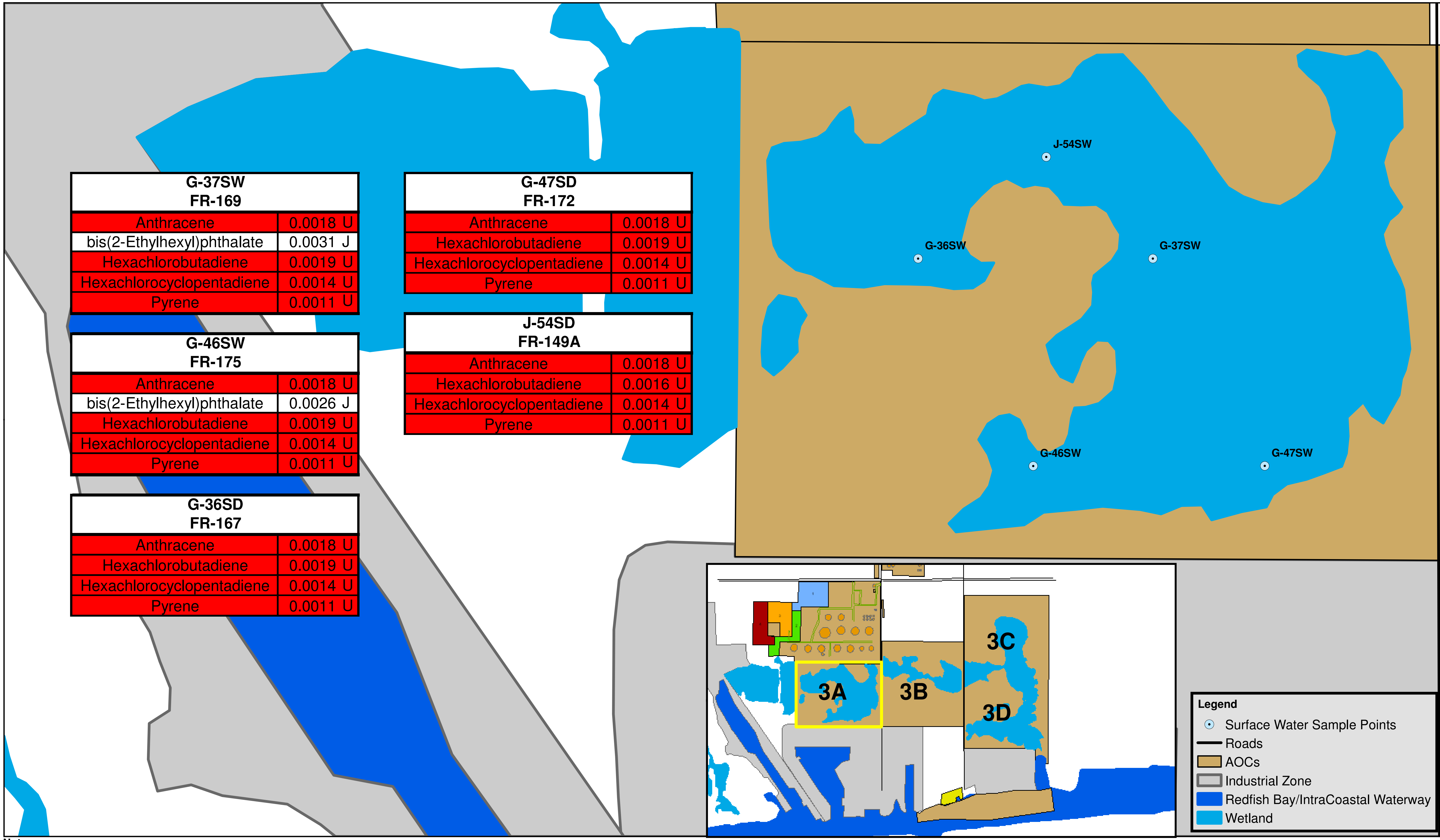
FIGURE
30D



G-37SW FR-169	
Anthracene	0.0018 U
bis(2-Ethylhexyl)phthalate	0.0031 J
Hexachlorobutadiene	0.0019 U
Hexachlorocyclopentadiene	0.0014 U
Pyrene	0.0011 U

G-46SW FR-175	
Anthracene	0.0018 U
bis(2-Ethylhexyl)phthalate	0.0026 J
Hexachlorobutadiene	0.0019 U
Hexachlorocyclopentadiene	0.0014 U
Pyrene	0.0011 U

G-36SD FR-167	
Anthracene	0.0018 U
Hexachlorobutadiene	0.0019 U
Hexachlorocyclopentadiene	0.0014 U
Pyrene	0.0011 U

G-47SD FR-172	
Anthracene	0.0018 U
Hexachlorobutadiene	0.0019 U
Hexachlorocyclopentadiene	0.0014 U
Pyrene	0.0011 U

J-54SD FR-149A	
Anthracene	0.0018 U
Hexachlorobutadiene	0.0016 U
Hexachlorocyclopentadiene	0.0014 U
Pyrene	0.0011 U

Notes:

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2. Qualifiers:
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   J = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds Marine Screening Level

0 100 200

Feet

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AOC-3A
Ecological
SVOC Surface Water Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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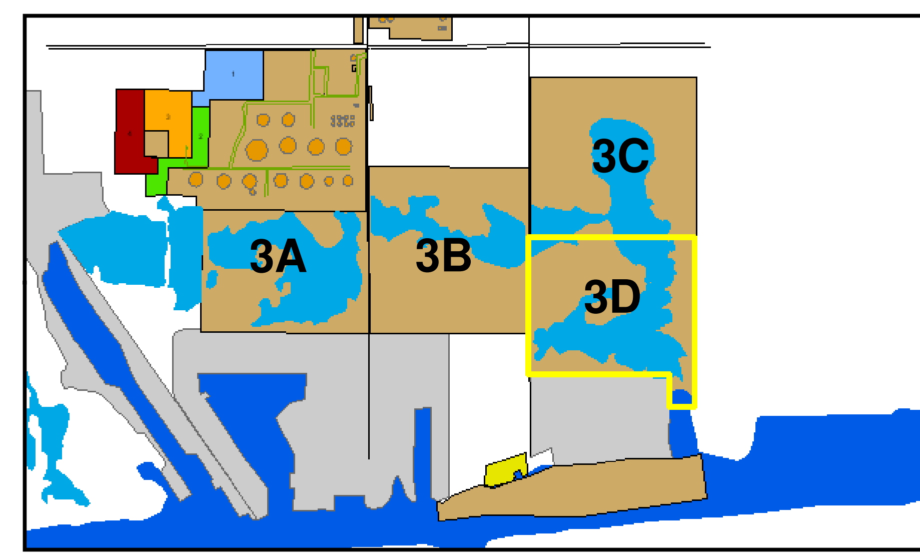
FIGURE

30E

J-57SW FR-211	
Anthracene	0.0018 U
bis(2-Ethylhexyl)phthalate	0.0026 J
Hexachlorobutadiene	0.0019 U
Hexachlorocyclopentadiene	0.0014 U
Pyrene	0.0011 U

J-58SD FR-217	
Anthracene	0.0018 U
Hexachlorobutadiene	0.0019 U
Hexachlorocyclopentadiene	0.0014 U
Pyrene	0.0011 U



Notes:

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2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

J = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds Marine Screening Level

0 100 200

Feet

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CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-3D
Ecological
SVOC Surface Water Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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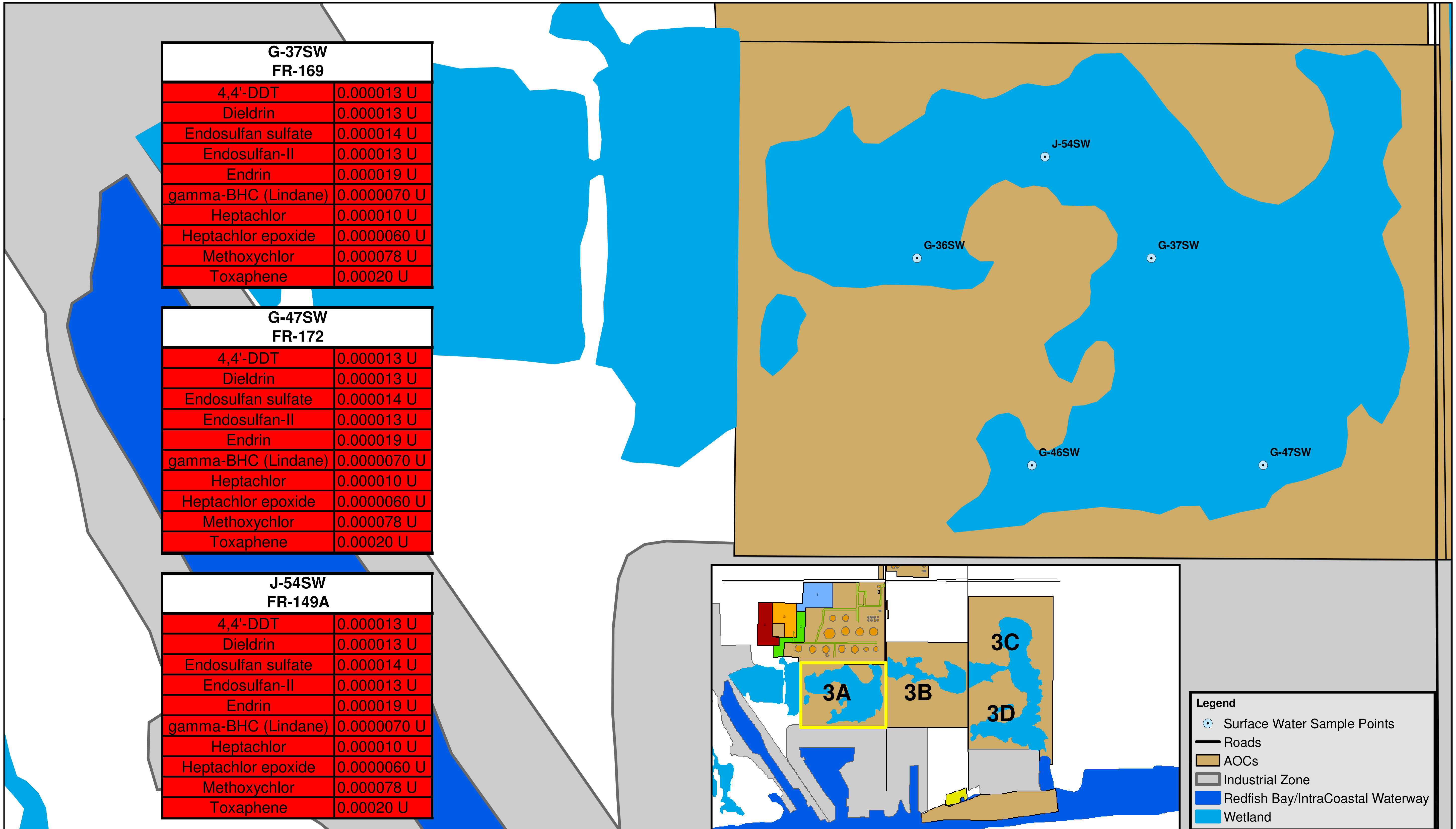
FIGURE
30F



G-37SW FR-169	
4,4'-DDT	0.000013 U
Dieldrin	0.000013 U
Endosulfan sulfate	0.000014 U
Endosulfan-II	0.000013 U
Endrin	0.000019 U
gamma-BHC (Lindane)	0.0000070 U
Heptachlor	0.000010 U
Heptachlor epoxide	0.0000060 U
Methoxychlor	0.000078 U
Toxaphene	0.00020 U

G-47SW FR-172	
4,4'-DDT	0.000013 U
Dieldrin	0.000013 U
Endosulfan sulfate	0.000014 U
Endosulfan-II	0.000013 U
Endrin	0.000019 U
gamma-BHC (Lindane)	0.0000070 U
Heptachlor	0.000010 U
Heptachlor epoxide	0.0000060 U
Methoxychlor	0.000078 U
Toxaphene	0.00020 U

J-54SW FR-149A	
4,4'-DDT	0.000013 U
Dieldrin	0.000013 U
Endosulfan sulfate	0.000014 U
Endosulfan-II	0.000013 U
Endrin	0.000019 U
gamma-BHC (Lindane)	0.0000070 U
Heptachlor	0.000010 U
Heptachlor epoxide	0.0000060 U
Methoxychlor	0.000078 U
Toxaphene	0.00020 U

Notes:

1. Results are posted in mg/l

2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

Exceeds Marine Screening Level

0 100 200

Feet

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APPROVED BY:	

AOC-3A
Ecological
Pesticide Surface Water Distribution Map

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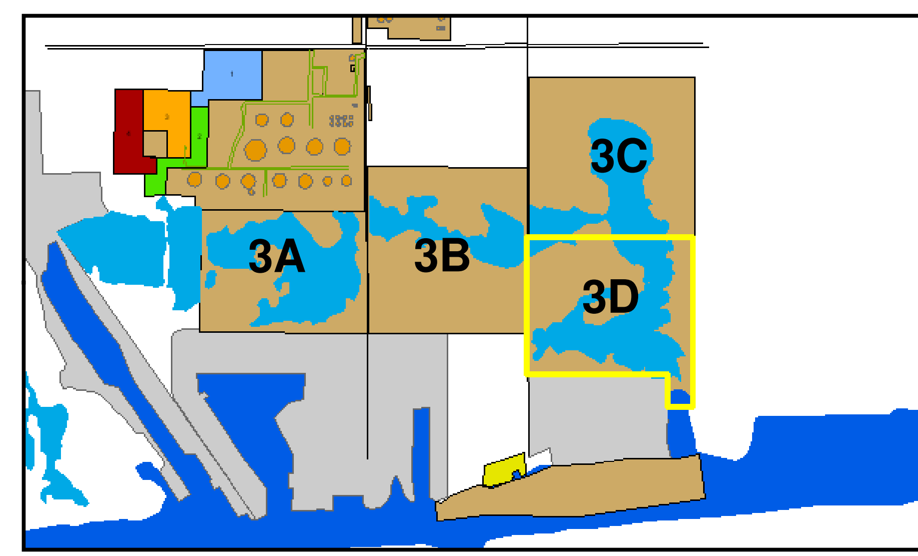
FIGURE

30G

J-57SW FR-211	
4,4'-DDT	0.000013 U
Dieldrin	0.000013 U
Endosulfan sulfate	0.000014 U
Endosulfan-II	0.000013 U
Endrin	0.000019 U
gamma-BHC (Lindane)	0.0000070 U
Heptachlor	0.000010 U
Heptachlor epoxide	0.0000060 U
Methoxychlor	0.000078 U
Toxaphene	0.00020 U

J-58SW FR-217	
4,4'-DDT	0.000013 U
Dieldrin	0.000013 U
Endosulfan sulfate	0.000014 U
Endosulfan-II	0.000013 U
Endrin	0.000019 U
gamma-BHC (Lindane)	0.0000070 U
Heptachlor	0.000010 U
Heptachlor epoxide	0.0000060 U
Methoxychlor	0.000078 U
Toxaphene	0.00020 U



Notes:

1. Results are posted in mg/l

2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

Exceeds Marine Screening Level

N

0 100 200

Feet

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DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

AOC-3D
Ecological
Pesticide Surface Water Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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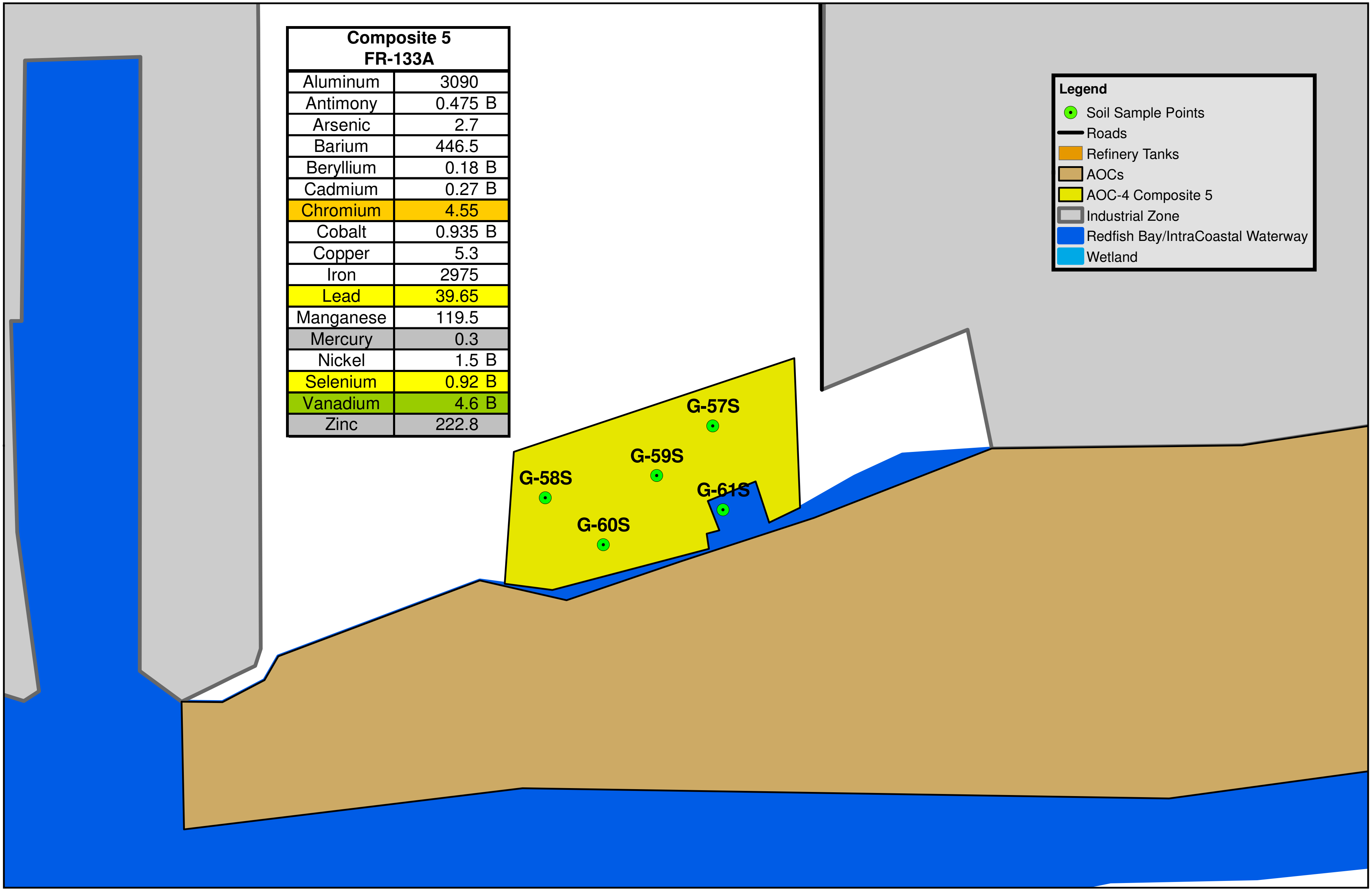
FIGURE

30H



Composite 5 FR-133A	
Aluminum	3090
Antimony	0.475 B
Arsenic	2.7
Barium	446.5
Beryllium	0.18 B
Cadmium	0.27 B
Chromium	4.55
Cobalt	0.935 B
Copper	5.3
Iron	2975
Lead	39.65
Manganese	119.5
Mercury	0.3
Nickel	1.5 B
Selenium	0.92 B
Vanadium	4.6 B
Zinc	222.8

Notes:

1. Results are posted in mg/kg

2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds Plant Limit
Exceeds Median Background Limit
Exceeds Earthworm and Plant Limits
Exceeds Earthworm, Plant, and Median Background Limits

N

0 50 100
Feet

DATE DRAWN: 5/7/08	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-4
Ecological
Metal Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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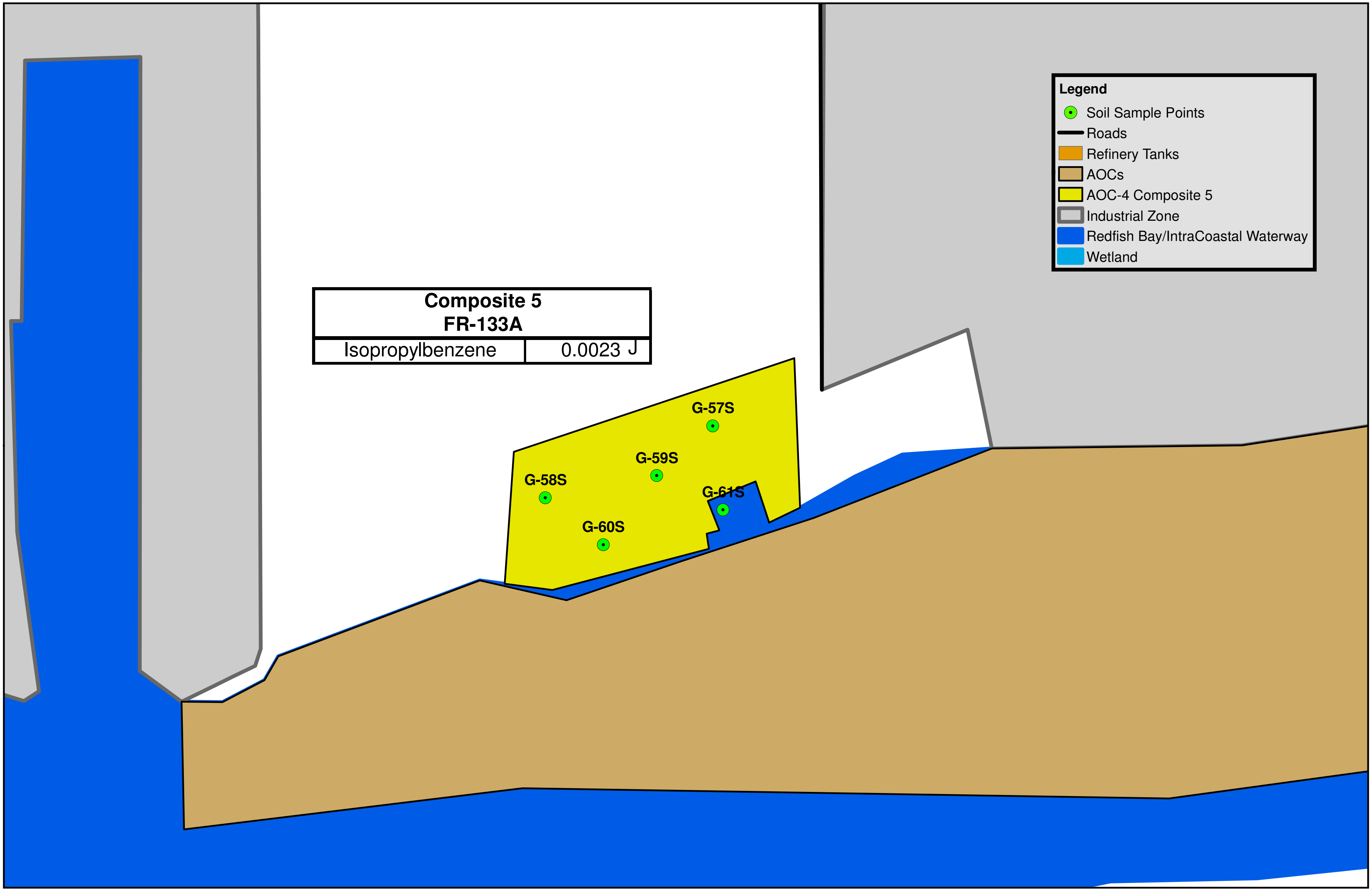
FIGURE
31A



Composite 5 FR-133A	
Isopropylbenzene	0.0023 J

Notes:

1. Results are posted in mg/kg

2. Qualifiers:

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

N

0 50 100

Feet

DATE DRAWN: 5/7/08	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-4
Ecological
VOC Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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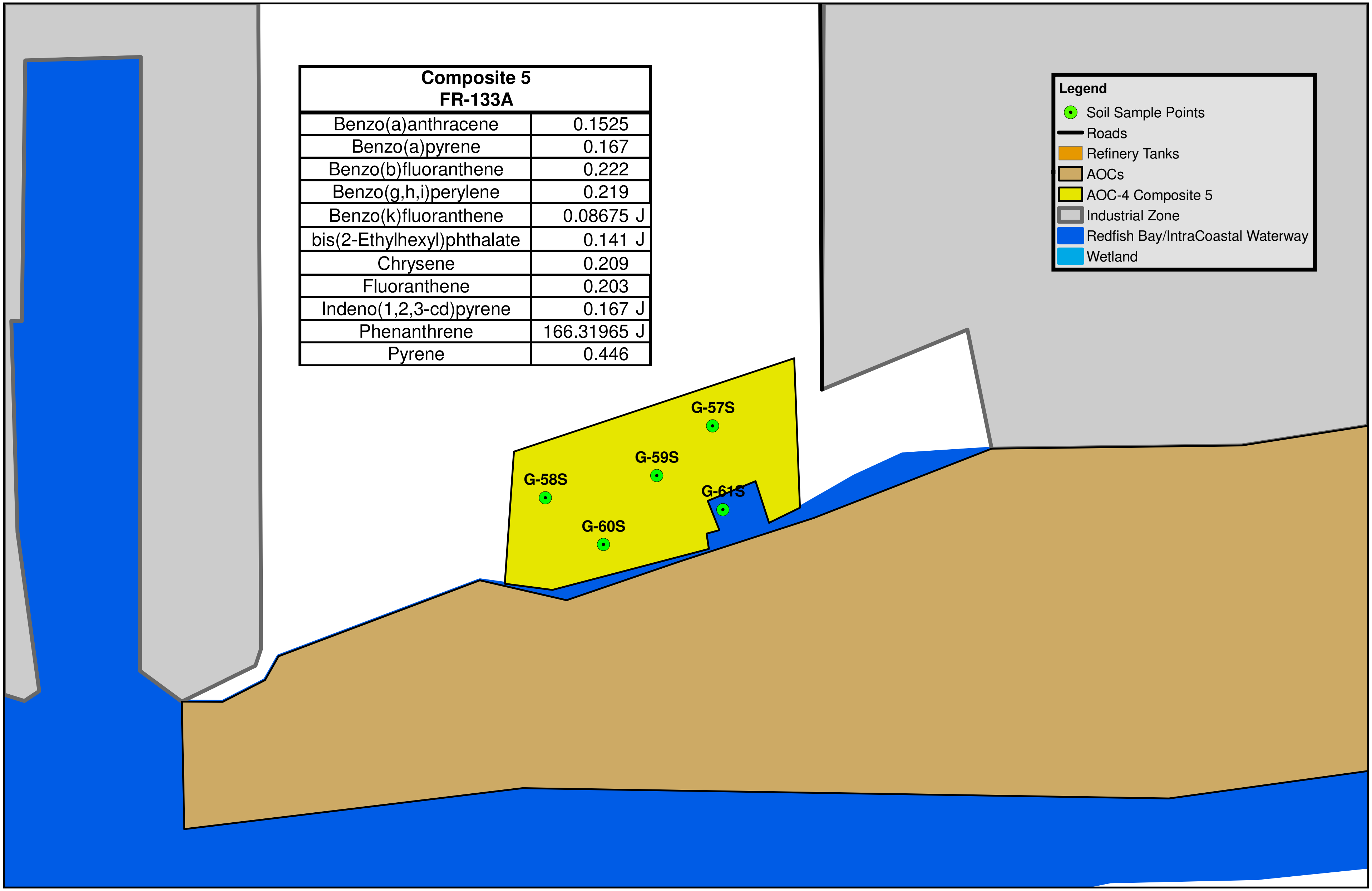
FIGURE
31B



Composite 5 FR-133A	
Benzo(a)anthracene	0.1525
Benzo(a)pyrene	0.167
Benzo(b)fluoranthene	0.222
Benzo(g,h,i)perylene	0.219
Benzo(k)fluoranthene	0.08675 J
bis(2-Ethylhexyl)phthalate	0.141 J
Chrysene	0.209
Fluoranthene	0.203
Indeno(1,2,3-cd)pyrene	0.167 J
Phenanthrene	166.31965 J
Pyrene	0.446

Notes:

1. Results are posted in mg/kg

2. Qualifiers:

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

N

0 50 100
Feet

DATE DRAWN: 5/7/08	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-4
Ecological
SVOC Surface Soil Distribution Map

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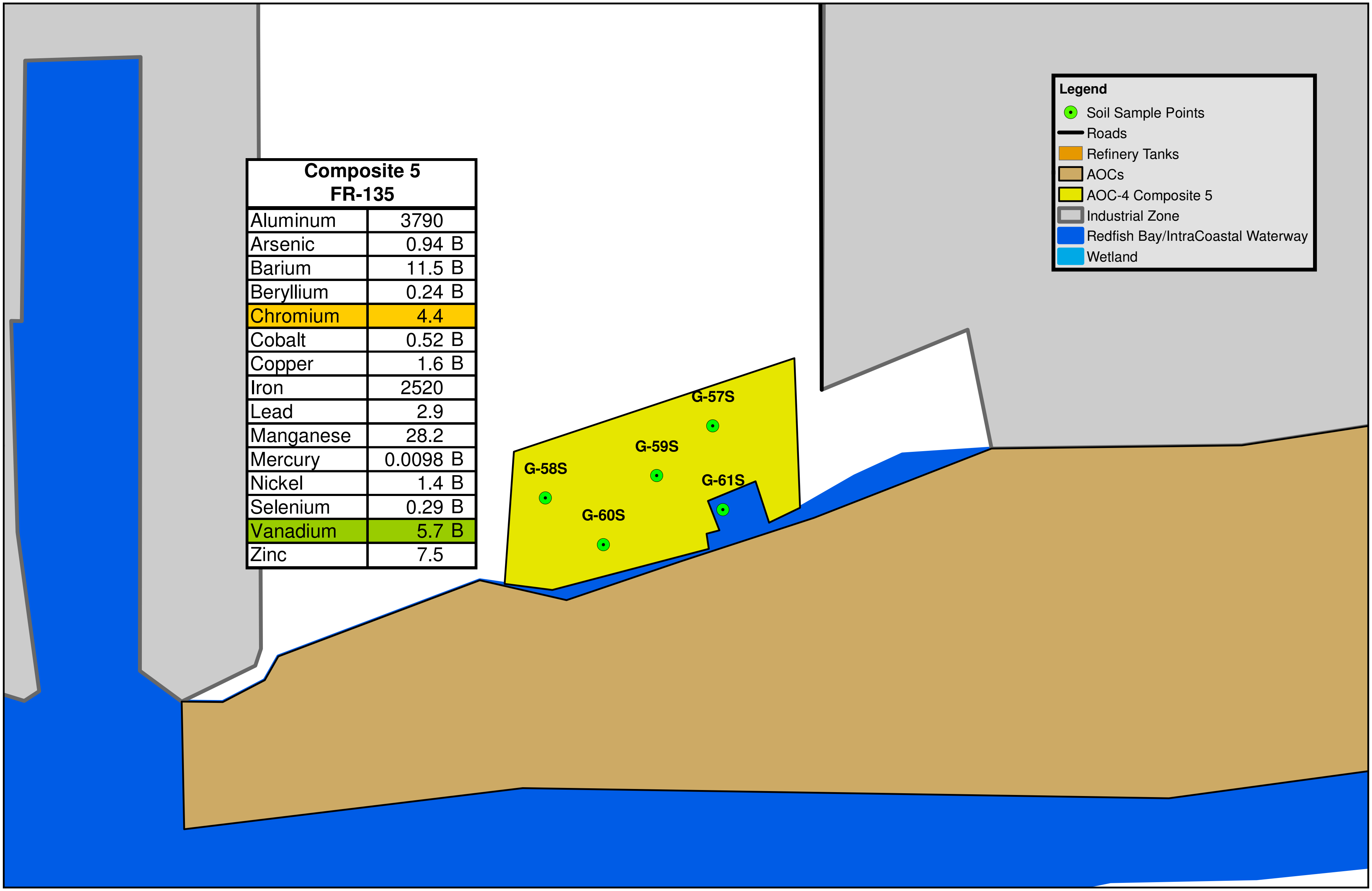
FIGURE
31C



Composite 5 FR-135	
Aluminum	3790
Arsenic	0.94 B
Barium	11.5 B
Beryllium	0.24 B
Chromium	4.4
Cobalt	0.52 B
Copper	1.6 B
Iron	2520
Lead	2.9
Manganese	28.2
Mercury	0.0098 B
Nickel	1.4 B
Selenium	0.29 B
Vanadium	5.7 B
Zinc	7.5

Notes:

1. Results are posted in mg/kg

2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds Plant Limit

Exceeds Earthworm and Plant Limits

N

0 50 100

Feet

DATE DRAWN: 5/7/08	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-4
Ecological
Metal Subsurface Soil Distribution Map

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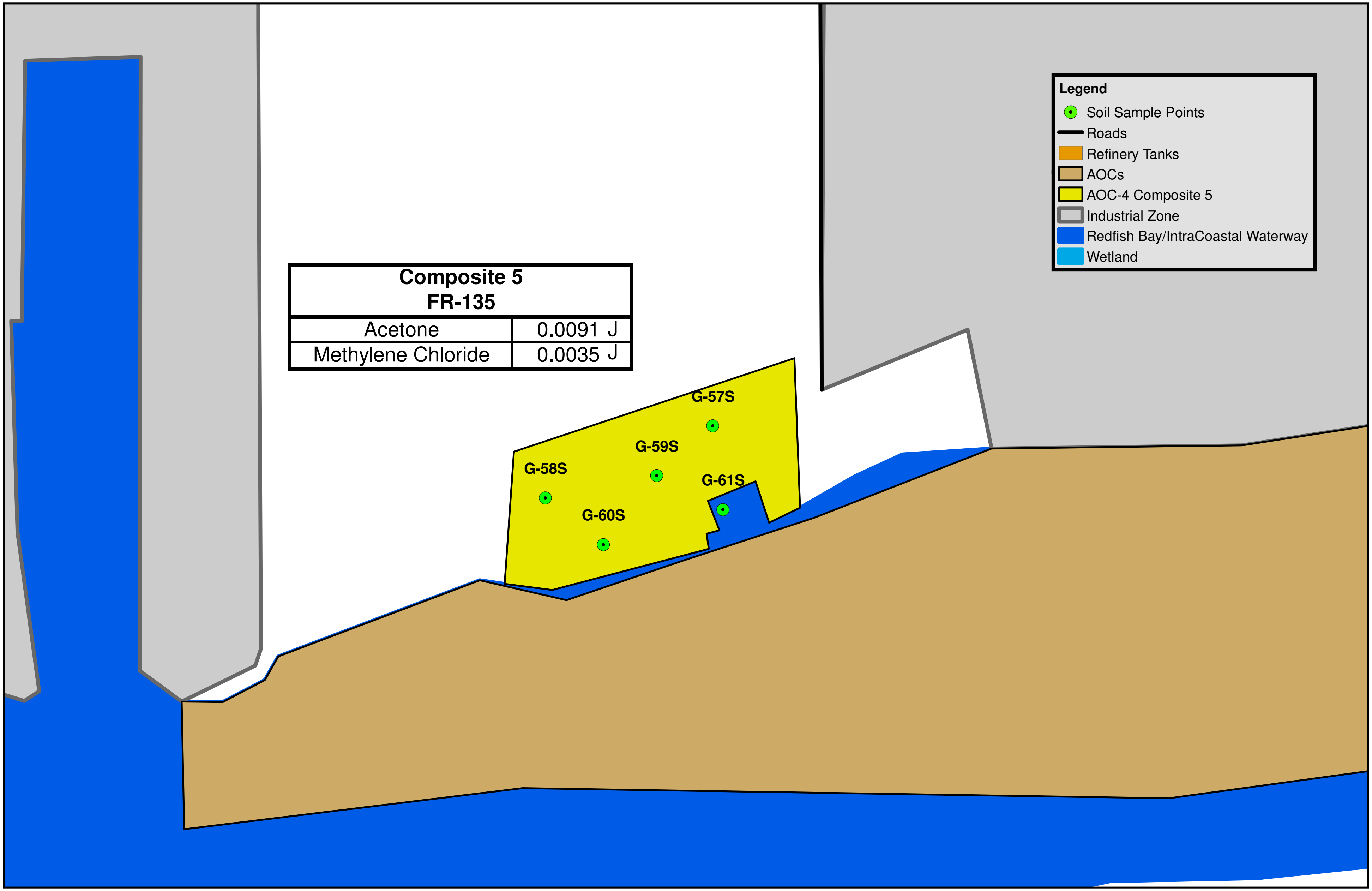
FIGURE

32A



Notes:

1. Results are posted in mg/kg

2. Qualifiers:

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

N

0 50 100

Feet

DATE DRAWN: 5/7/08	DATE REVISED: 4/1/09	**AOC-4 Ecological VOC Subsurface Soil Distribution Map**	FIGURE
DRAFTED BY: C. SEATON			**32B**
CHECKED BY: S. HALASZ		FALCON REFINERY INGLESIDE, SAN PATRICIO COUNTY, TEXAS	
APPROVED BY:		PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map	

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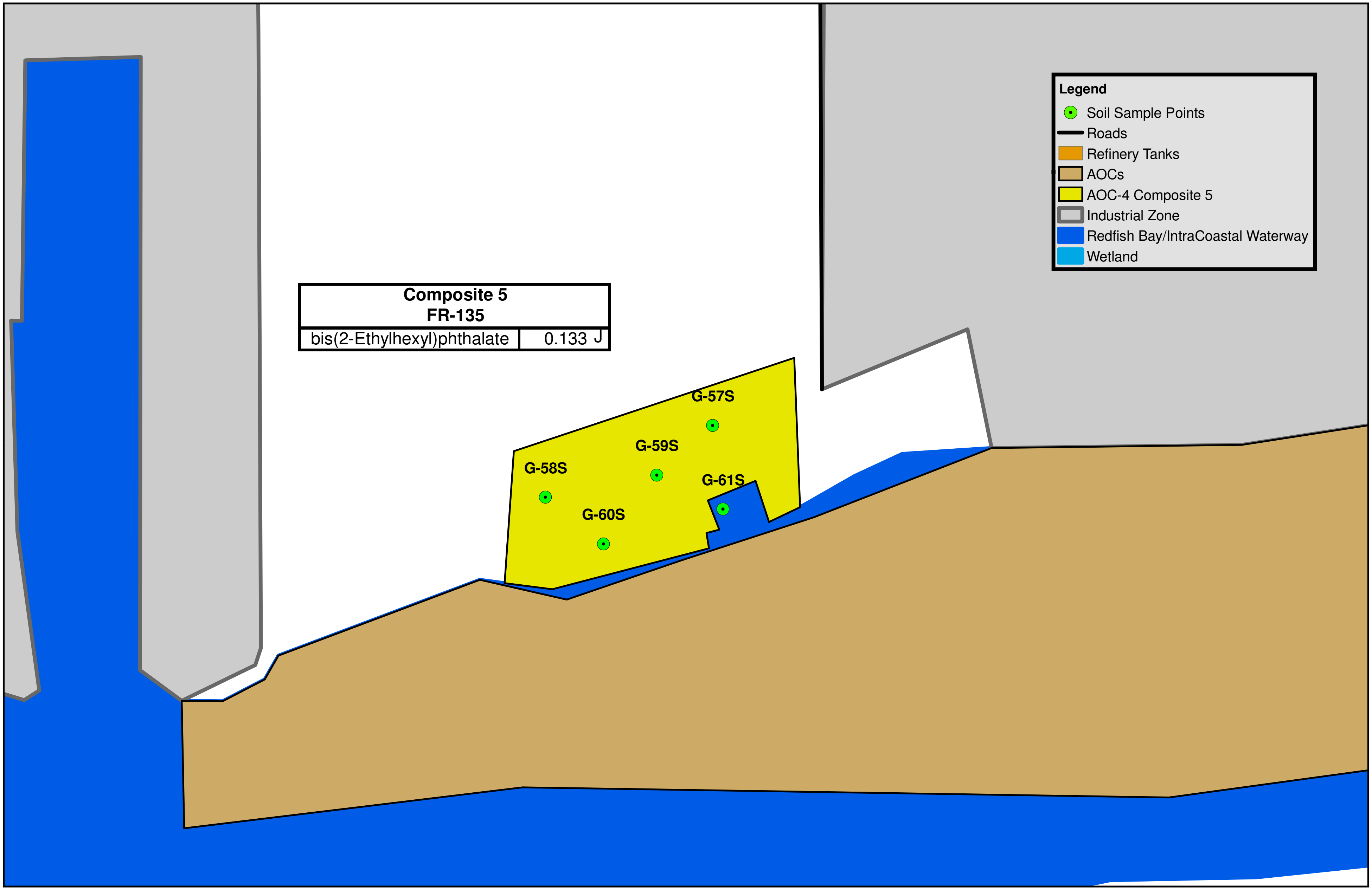

Notes:

1. Results are posted in mg/kg

2. Qualifiers:

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

DATE DRAWN: 5/7/08	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-4
Ecological
SVOC Subsurface Soil Distribution Map

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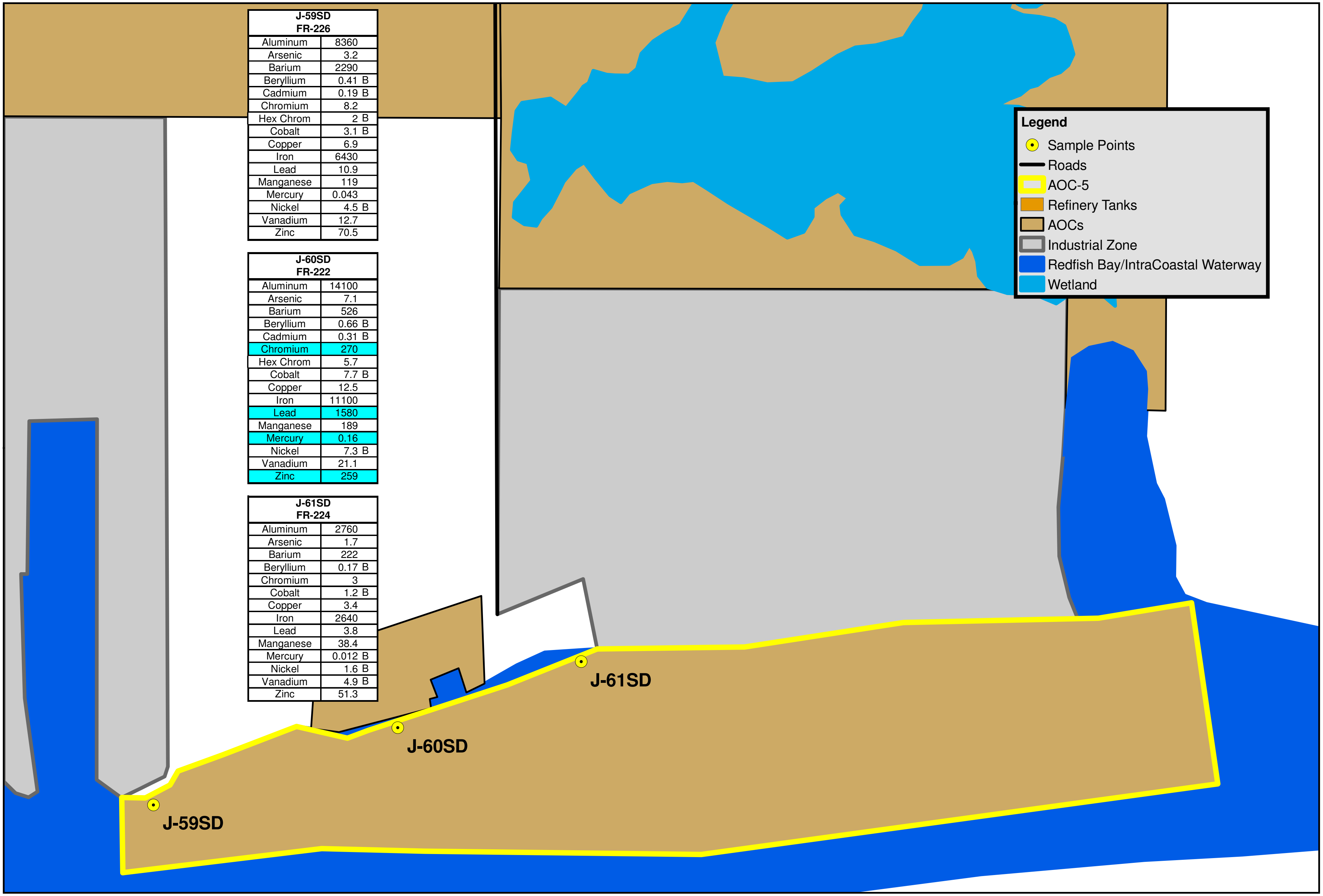
FIGURE

32C



J-59SD FR-226	
Aluminum	8360
Arsenic	3.2
Barium	2290
Beryllium	0.41 B
Cadmium	0.19 B
Chromium	8.2
Hex Chrom	2 B
Cobalt	3.1 B
Copper	6.9
Iron	6430
Lead	10.9
Manganese	119
Mercury	0.043
Nickel	4.5 B
Vanadium	12.7
Zinc	70.5

J-60SD FR-222	
Aluminum	14100
Arsenic	7.1
Barium	526
Beryllium	0.66 B
Cadmium	0.31 B
Chromium	270
Hex Chrom	5.7
Cobalt	7.7 B
Copper	12.5
Iron	11100
Lead	1580
Manganese	189
Mercury	0.16
Nickel	7.3 B
Vanadium	21.1
Zinc	259

J-61SD FR-224	
Aluminum	2760
Arsenic	1.7
Barium	222
Beryllium	0.17 B
Chromium	3
Cobalt	1.2 B
Copper	3.4
Iron	2640
Lead	3.8
Manganese	38.4
Mercury	0.012 B
Nickel	1.6 B
Vanadium	4.9 B
Zinc	51.3

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Above Sediment Marine Limit

0 100 200
Feet

DATE DRAWN: 5/7/08	DATE REVISED: 4/1/09
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CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-5
Ecological
Metal Sediment Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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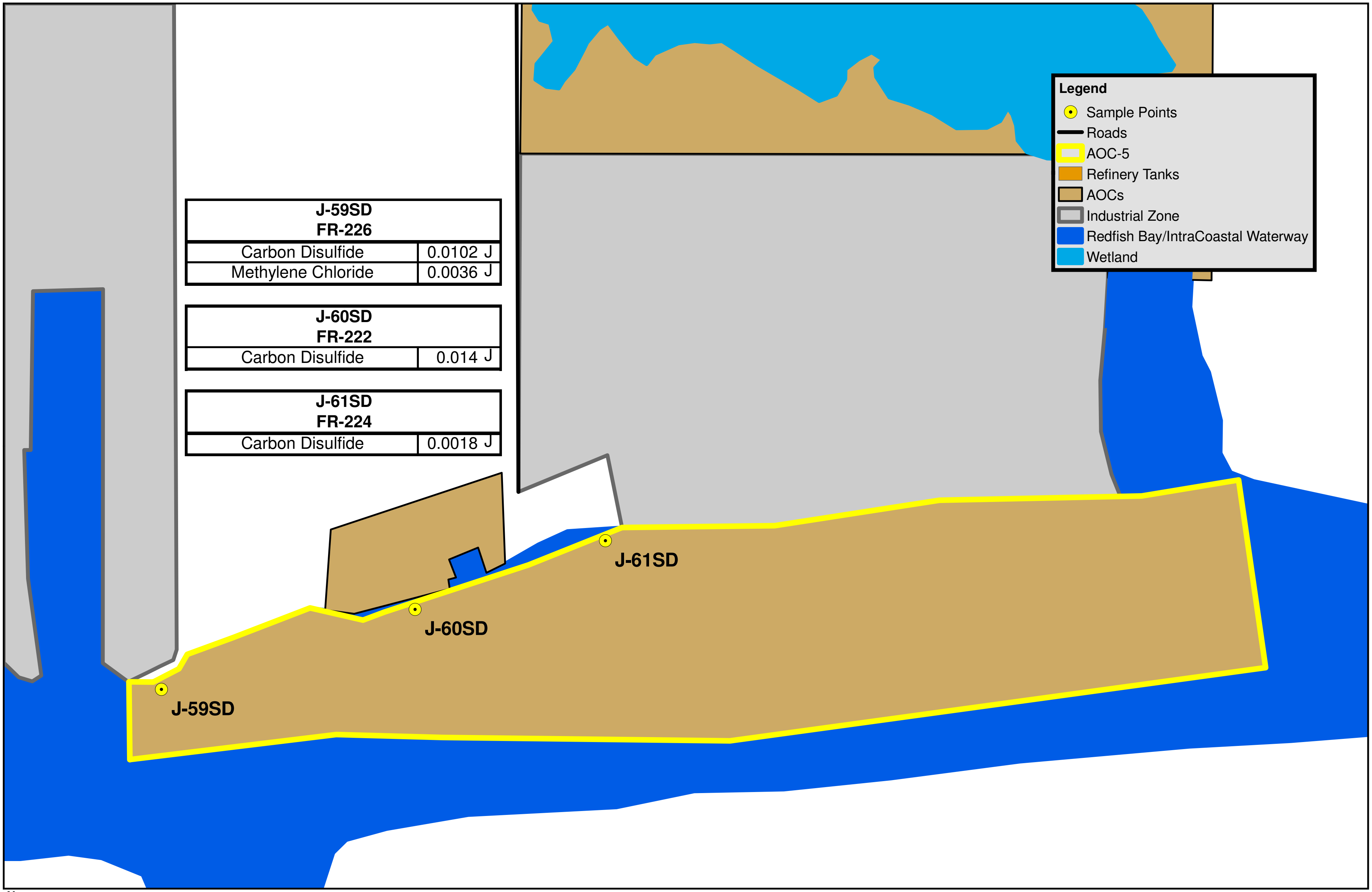
FIGURE
33A



Notes:

1. Results are posted in mg/kg

2. Qualifiers:

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

N

0 110 220

Feet

DATE DRAWN: 5/7/08	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-5
Ecological
VOC Sediment Distribution Map

FALCON REFINERY
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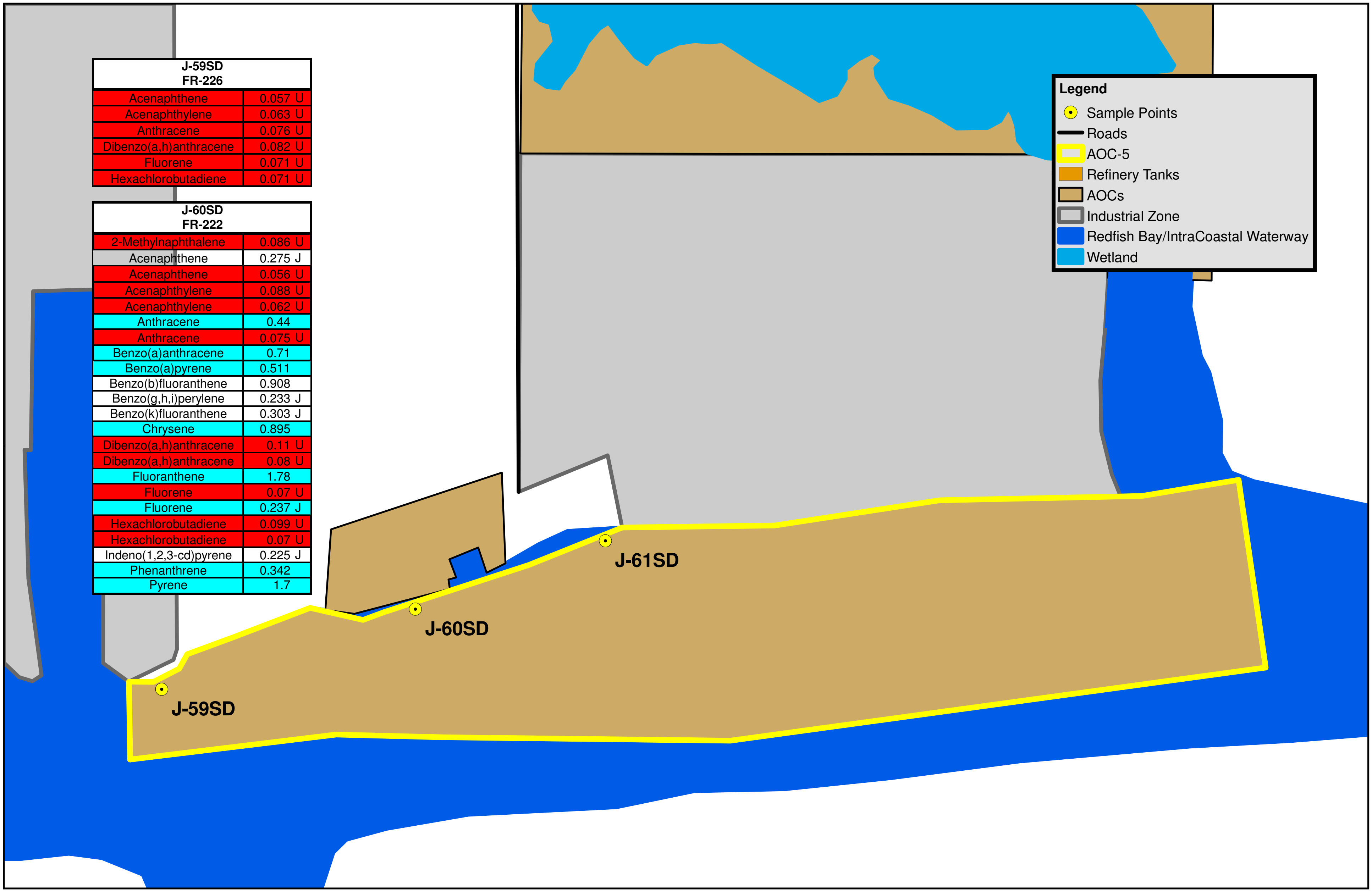
FIGURE

33B



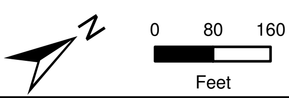
J-59SD FR-226	
Acenaphthene	0.057 U
Acenaphthylene	0.063 U
Anthracene	0.076 U
Dibenzo(a,h)anthracene	0.082 U
Fluorene	0.071 U
Hexachlorobutadiene	0.071 U

J-60SD FR-222	
2-Methylnaphthalene	0.086 U
Acenaphthene	0.275 J
Acenaphthene	0.056 U
Acenaphthylene	0.088 U
Acenaphthylene	0.062 U
Anthracene	0.44
Anthracene	0.075 U
Benzo(a)anthracene	0.71
Benzo(a)pyrene	0.511
Benzo(b)fluoranthene	0.908
Benzo(g,h,i)perylene	0.233 J
Benzo(k)fluoranthene	0.303 J
Chrysene	0.895
Dibenzo(a,h)anthracene	0.11 U
Dibenzo(a,h)anthracene	0.08 U
Fluoranthene	1.78
Fluorene	0.07 U
Fluorene	0.237 J
Hexachlorobutadiene	0.099 U
Hexachlorobutadiene	0.07 U
Indeno(1,2,3-cd)pyrene	0.225 J
Phenanthrene	0.342
Pyrene	1.7

Notes:

1. Results are posted in mg/kg
2. Qualifiers:
   U = Undetected at the sample detection limit (SDL)
   J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

Above Sediment Marine Limit
Exceeds Sediment Marine Screening Level



DATE DRAWN: 5/7/08	DATE REVISED: 4/1/09
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CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-5
Ecological
SVOC Sediment Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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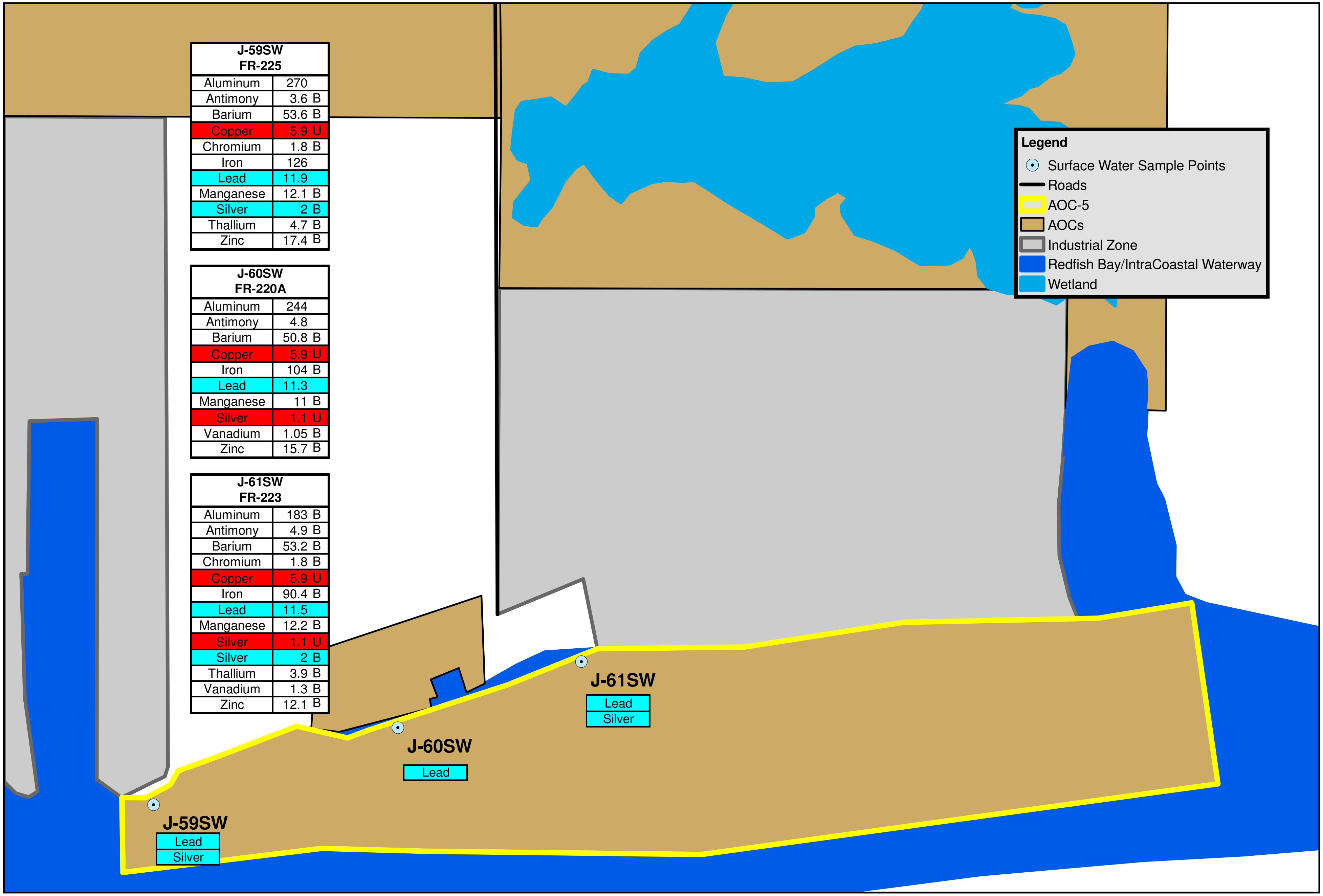
FIGURE
33C



Notes:

1. Results are posted in µg/l
2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Above Marine Limit

Exceeds Marine Screening Level

0 100 200

Feet

DATE DRAWN: 5/7/08	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-5
Ecological
Metal Surface Water Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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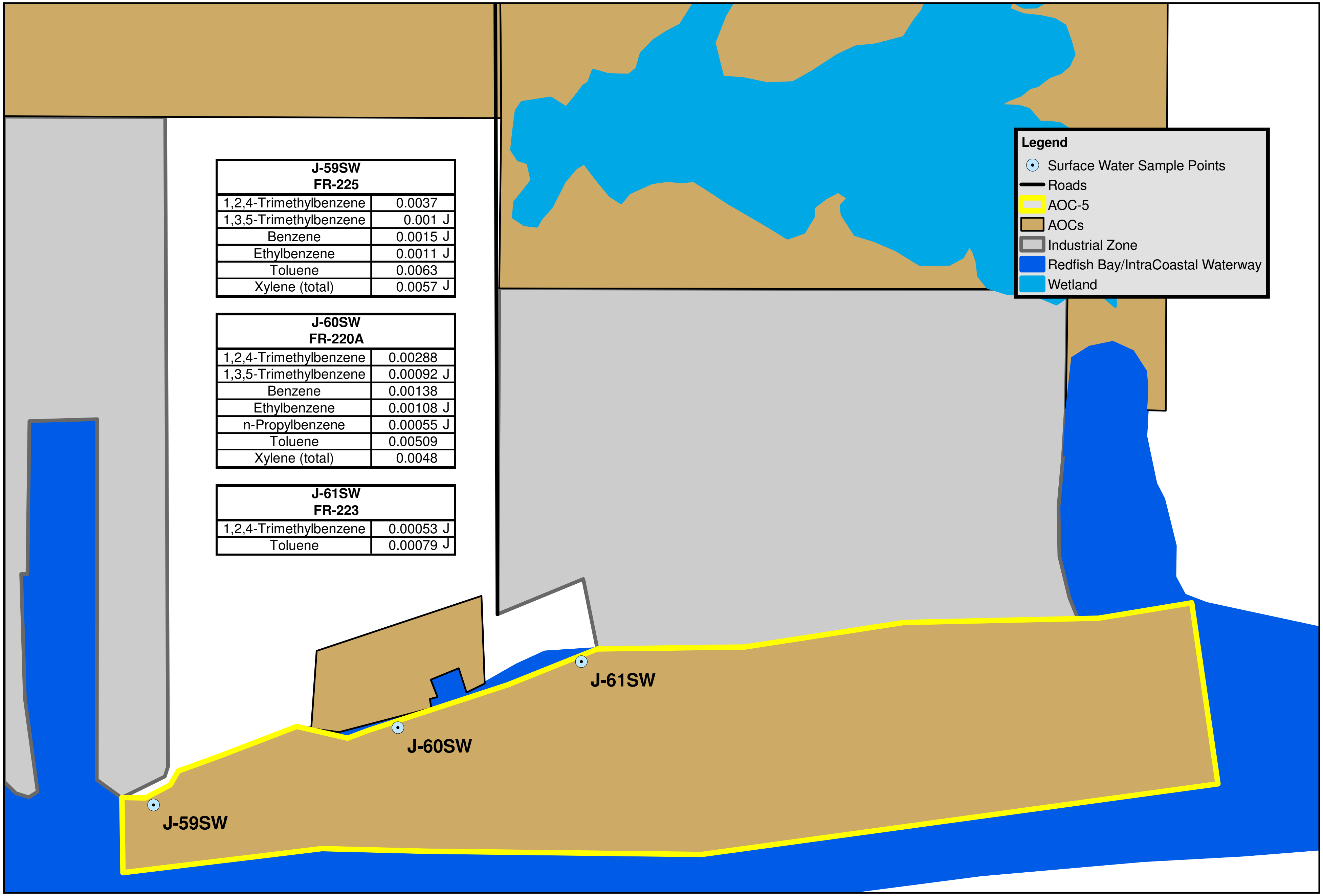
FIGURE

34A



J-59SW FR-225	
1,2,4-Trimethylbenzene	0.0037
1,3,5-Trimethylbenzene	0.001 J
Benzene	0.0015 J
Ethylbenzene	0.0011 J
Toluene	0.0063
Xylene (total)	0.0057 J

J-60SW FR-220A	
1,2,4-Trimethylbenzene	0.00288
1,3,5-Trimethylbenzene	0.00092 J
Benzene	0.00138
Ethylbenzene	0.00108 J
n-Propylbenzene	0.00055 J
Toluene	0.00509
Xylene (total)	0.0048

J-61SW FR-223	
1,2,4-Trimethylbenzene	0.00053 J
Toluene	0.00079 J

Notes:

1. Results are posted in mg/l

2. Qualifiers:

J = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

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APPROVED BY:	

AOC-5
Ecological
VOC Surface Water Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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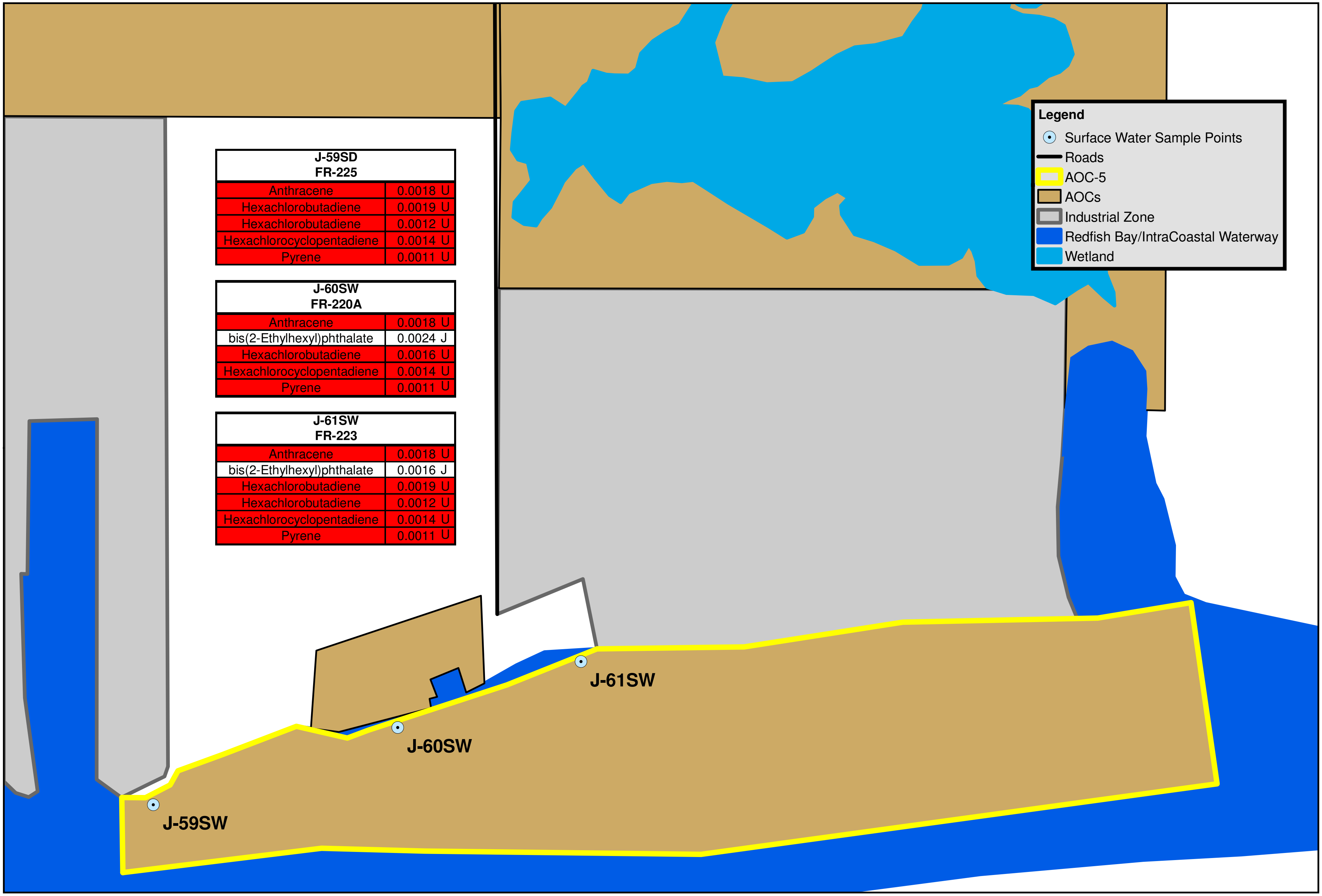
FIGURE
34B



J-59SD FR-225	
Anthracene	0.0018 U
Hexachlorobutadiene	0.0019 U
Hexachlorobutadiene	0.0012 U
Hexachlorocyclopentadiene	0.0014 U
Pyrene	0.0011 U

J-60SW FR-220A	
Anthracene	0.0018 U
bis(2-Ethylhexyl)phthalate	0.0024 J
Hexachlorobutadiene	0.0016 U
Hexachlorocyclopentadiene	0.0014 U
Pyrene	0.0011 U

J-61SW FR-223	
Anthracene	0.0018 U
bis(2-Ethylhexyl)phthalate	0.0016 J
Hexachlorobutadiene	0.0019 U
Hexachlorobutadiene	0.0012 U
Hexachlorocyclopentadiene	0.0014 U
Pyrene	0.0011 U

Notes:

1. Results are posted in mg/l
2. Qualifiers:
   - U = Undetected at the sample detection limit (SDL)
   - J = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds Marine Screening Level

N

0 100 200

Feet

DATE DRAWN: 5/7/08	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-5
Ecological
SVOC Surface Water Distribution Map

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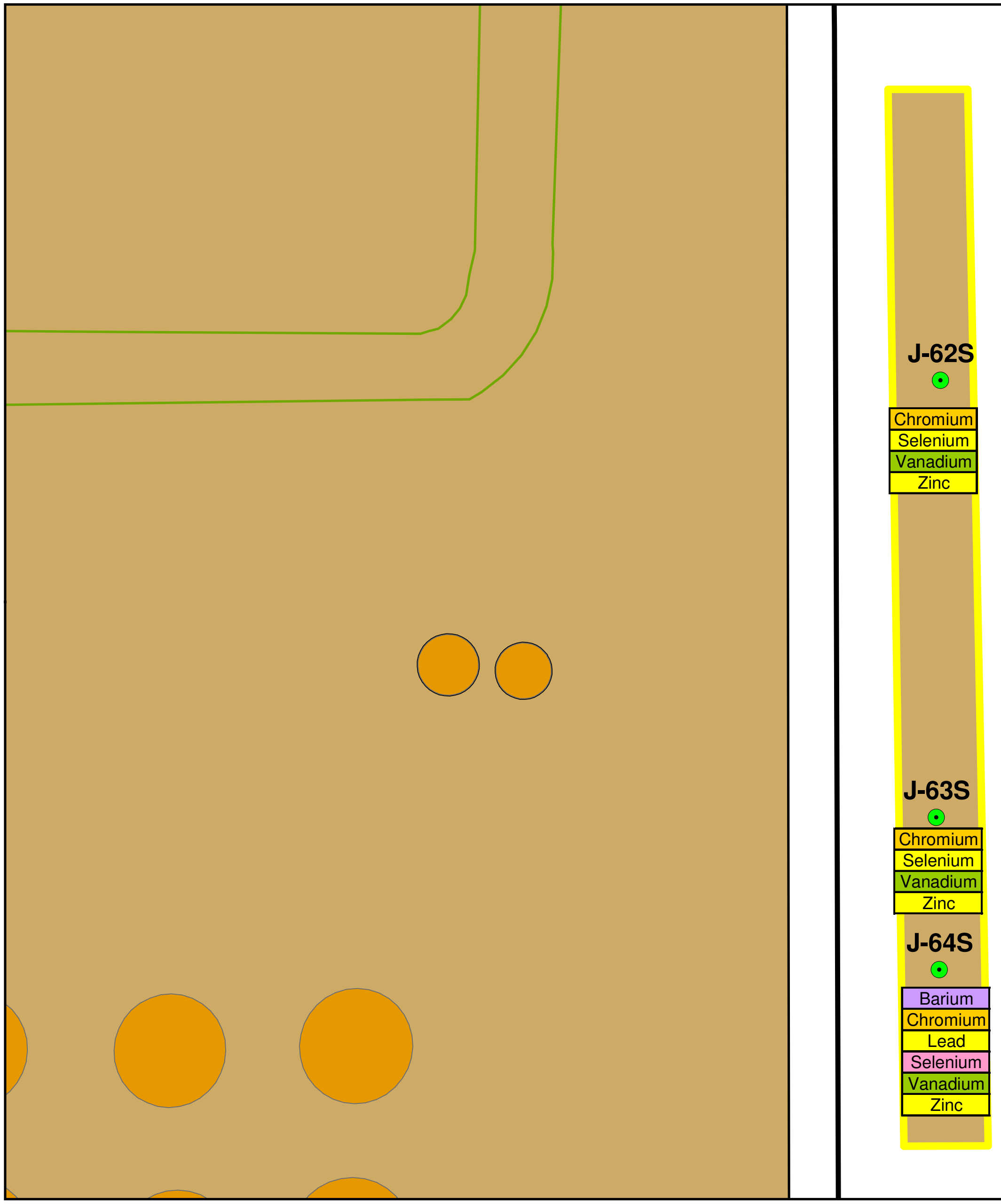
FIGURE
34C



J-62S FR-234A	
Aluminum	11750
Arsenic	1.5
Barium	259
Beryllium	0.495
Cadmium	0.17 B
Chromium	12.25
Cobalt	2.75 B
Copper	8.45
Iron	7025
Lead	8.6
Manganese	180
Mercury	0.00405 B
Nickel	6
Selenium	0.795 B
Vanadium	19.45
Zinc	71.25

J-63S FR-231	
Aluminum	9190
Arsenic	2.4
Barium	280
Beryllium	0.43 B
Cadmium	0.13 B
Chromium	10.8
Cobalt	2.4 B
Copper	9.1
Iron	6580
Lead	7.1
Manganese	133
Mercury	0.0067 B
Nickel	7.5
Selenium	0.78 B
Vanadium	32.5
Zinc	69.3

J-64S FR-228	
Aluminum	10600
Arsenic	2.8
Barium	400
Beryllium	0.45 B
Cadmium	0.16 B
Chromium	15.3
Cobalt	2.7 B
Copper	14.6
Iron	7630
Lead	16.5
Manganese	157
Mercury	0.0094 B
Nickel	7.2
Selenium	1.2
Vanadium	20.6
Zinc	111

Legend

- Soil Sample Points
- Roads
- Gravel/Dirt Road
- AOC-6
- Refinery Tanks
- AOCs

Notes:

1. Results are posted in mg/kg

2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

- Exceeds Plant Limit
- Exceeds Median Background Limit
- Exceeds Earthworm and Plant Limits
- Exceeds Earthworm and Median Background Limits
- Exceeds Plant and Median Background Limits

N

0 25 50

Feet

DATE DRAWN: 5/7/08

DATE REVISED: 4/1/09

DRAFTED BY: C. SEATON

CHECKED BY: S. HALASZ

APPROVED BY:

AOC-6
Ecological
Metal Surface Soil Distribution Map

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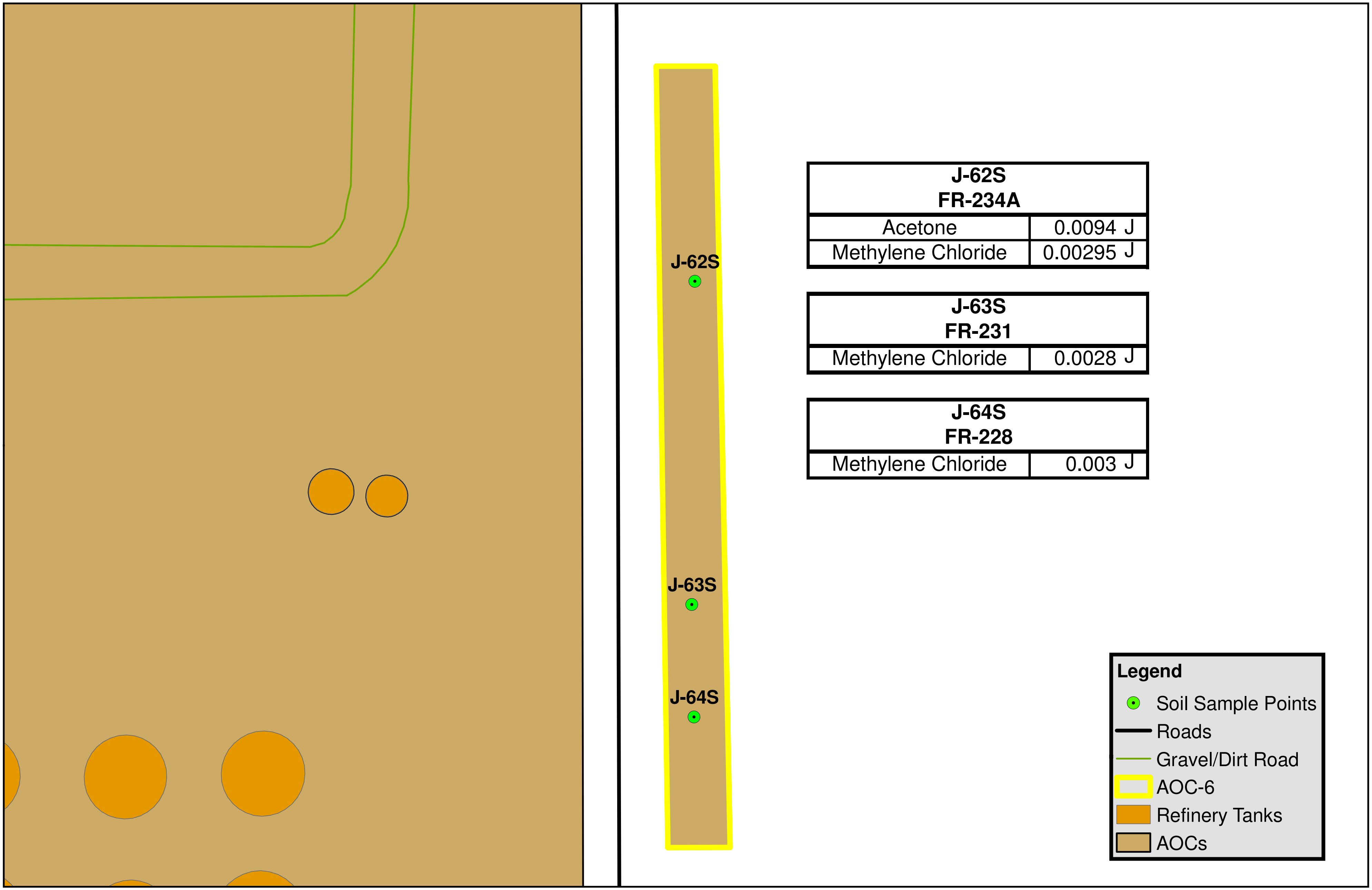
FIGURE

35A



J-62S FR-234A	
Acetone	0.0094 J
Methylene Chloride	0.00295 J

J-63S FR-231	
Methylene Chloride	0.0028 J

J-64S FR-228	
Methylene Chloride	0.003 J

Notes:

1. Results are posted in mg/kg

2. Qualifiers:

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

DATE DRAWN: 5/7/08	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-6
Ecological
VOC Surface Soil Distribution Map

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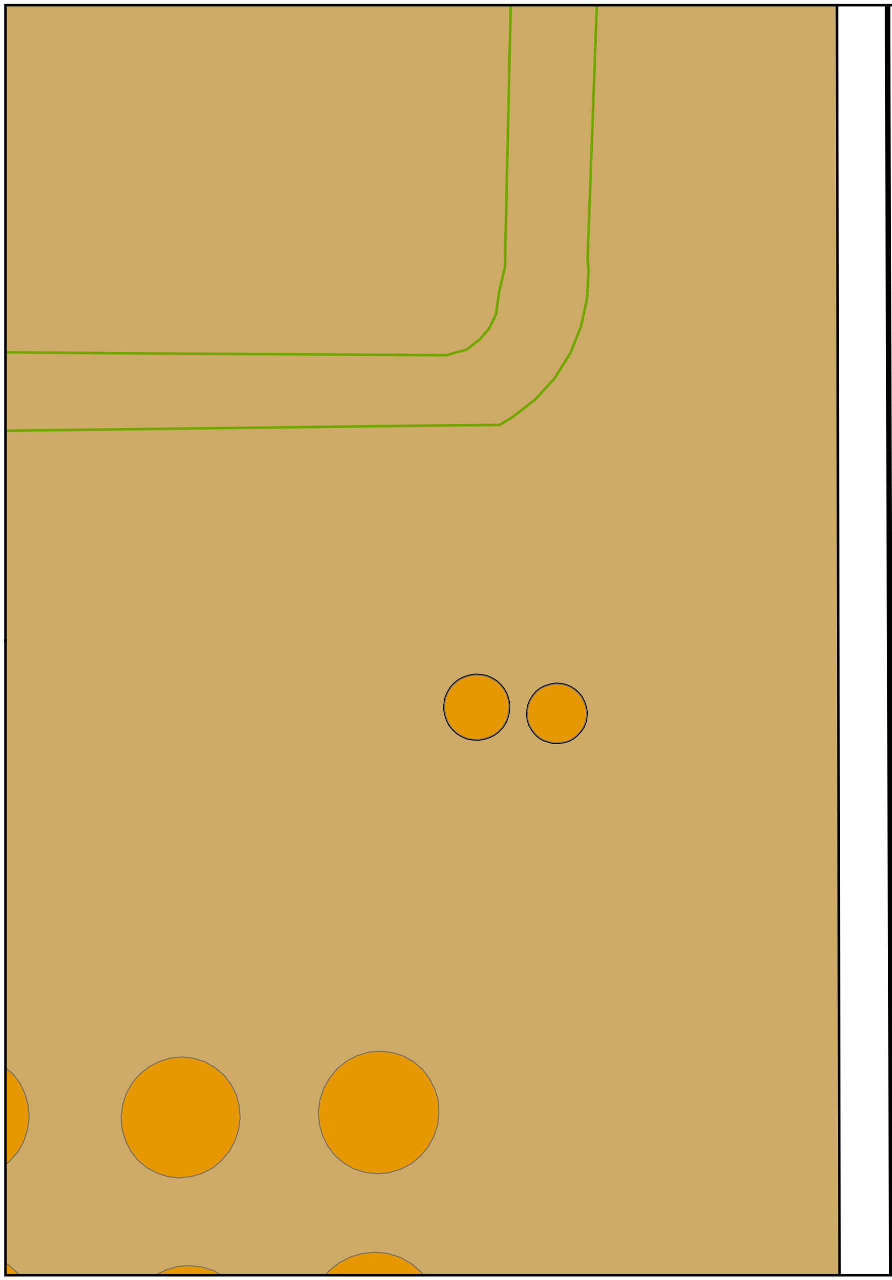
FIGURE
35B



J-62S FR-236	
Aluminum	2660
Barium	21.5 B
Beryllium	0.14 B
Chromium	2.1
Cobalt	0.2 B
Copper	1.2 B
Iron	956
Lead	2.6
Manganese	5.2
Mercury	0.025
Nickel	0.39 B
Vanadium	2.4 B
Zinc	3.7

J-63S FR-232	
Aluminum	4340
Arsenic	0.35 B
Barium	39.6
Beryllium	0.22 B
Chromium	4
Cobalt	0.3 B
Copper	1.9 B
Iron	1500
Lead	3.1
Manganese	7.5
Mercury	0.0064 B
Nickel	0.74 B
Vanadium	3.6 B
Zinc	5.8

J-64S FR-229	
Aluminum	1420
Barium	20.1 B
Beryllium	0.075 B
Chromium	2.3
Hex Chrom	1.5 B
Copper	1.5 B
Iron	737
Lead	2.1
Manganese	4.5
Mercury	0.0083 B
Nickel	0.25 B
Vanadium	1.6 B
Zinc	3

Legend
- Sample Points
- Roads
- Gravel/Dirt Road
- AOC-6
- Refinery Tanks
- AOCs

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds Plant Limit

Exceeds Earthworm and Plant Limits

N

0 25 50
Feet

DATE DRAWN: 5/7/08	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-6
Ecological
Metal Subsurface Soil Distribution Map

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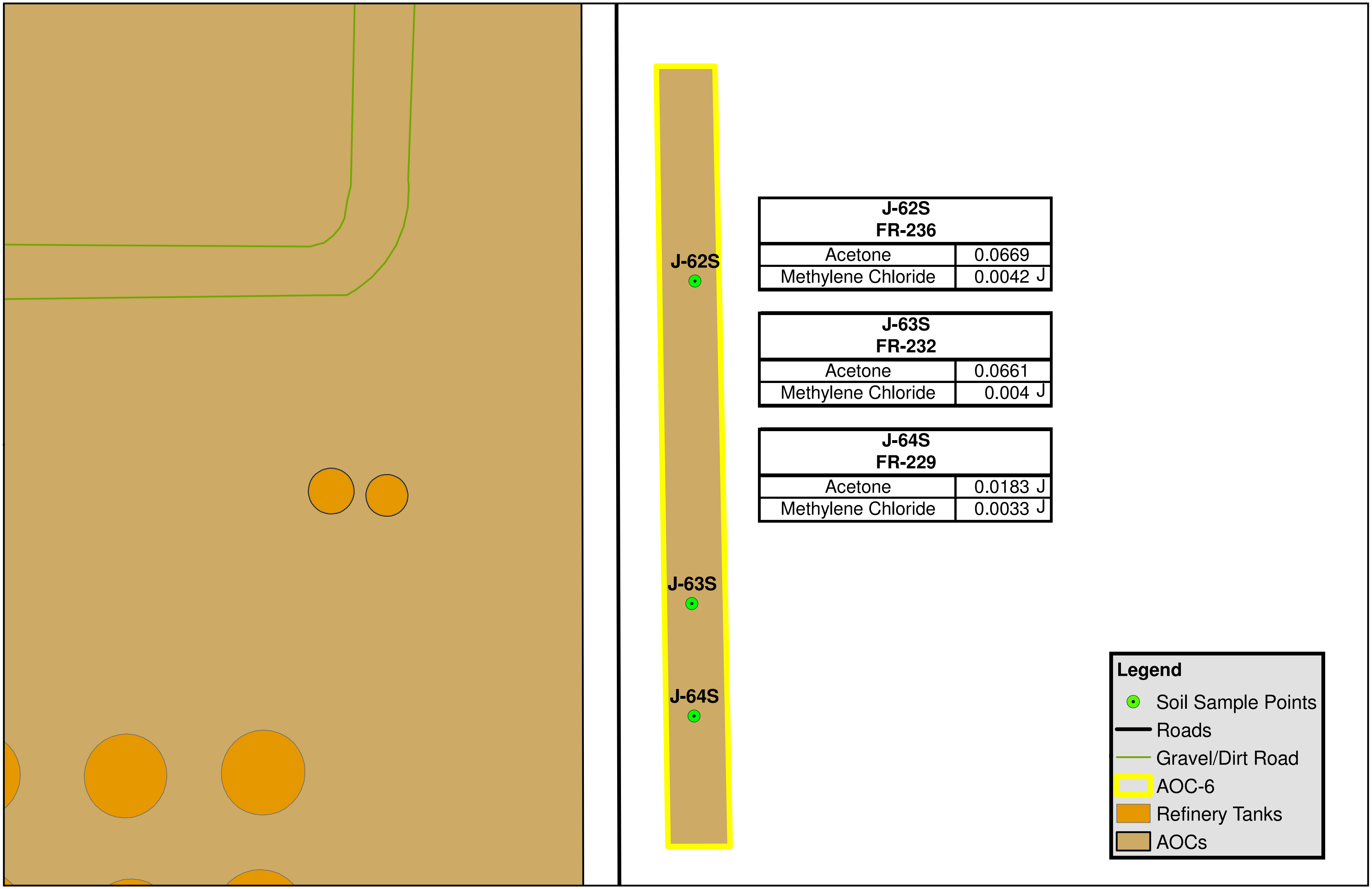
FIGURE
36A



J-62S FR-236	
Acetone	0.0669
Methylene Chloride	0.0042 J

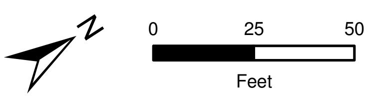
J-63S FR-232	
Acetone	0.0661
Methylene Chloride	0.004 J

J-64S FR-229	
Acetone	0.0183 J
Methylene Chloride	0.0033 J

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

   J = Concentration greater than the SDL but less than the method quantitation limit (MQL)



DATE DRAWN: 5/7/08	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-6
Ecological
VOC Subsurface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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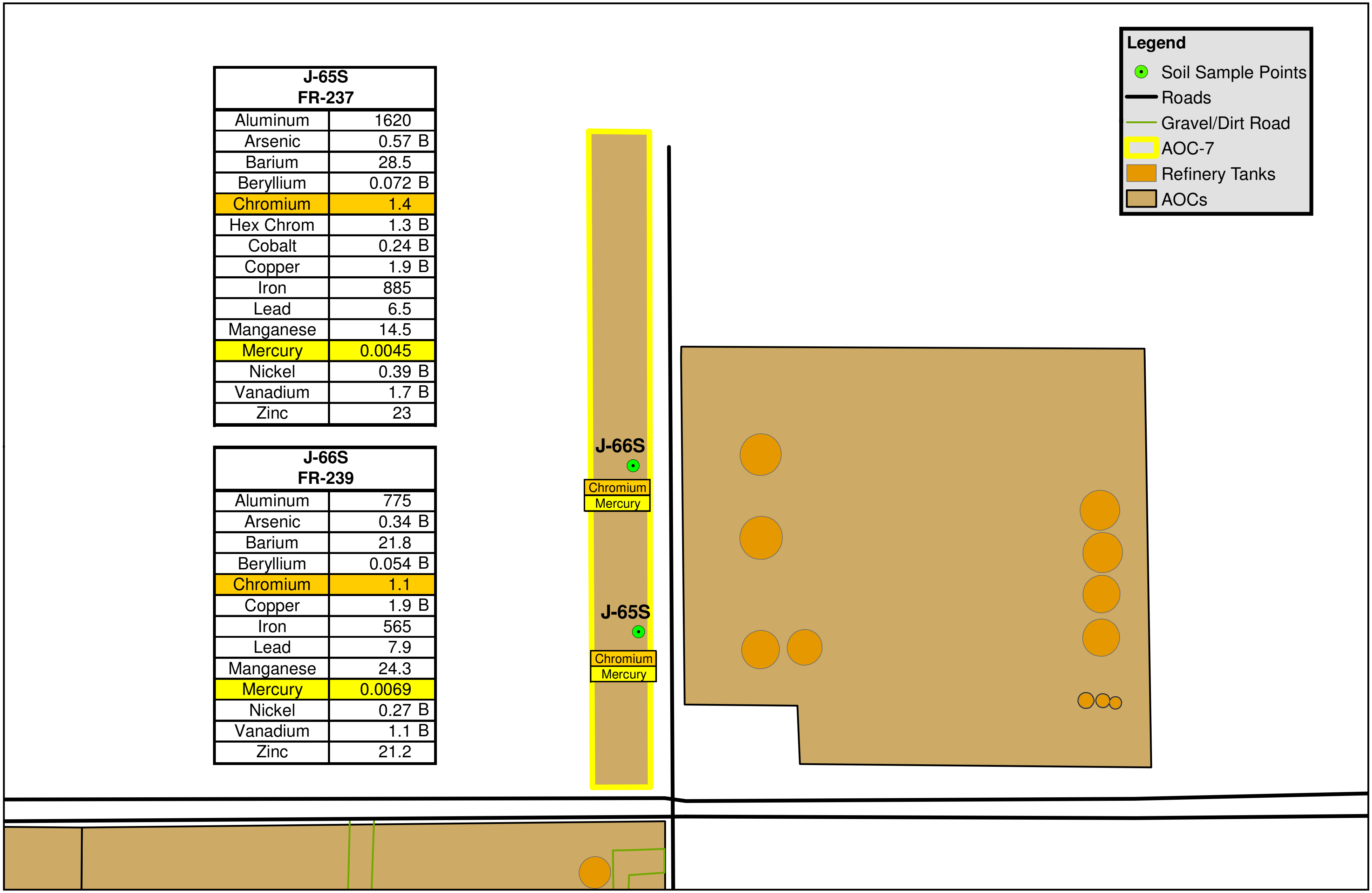
FIGURE
36B



J-65S FR-237	
Aluminum	1620
Arsenic	0.57 B
Barium	28.5
Beryllium	0.072 B
Chromium	1.4
Hex Chrom	1.3 B
Cobalt	0.24 B
Copper	1.9 B
Iron	885
Lead	6.5
Manganese	14.5
Mercury	0.0045
Nickel	0.39 B
Vanadium	1.7 B
Zinc	23

J-66S FR-239	
Aluminum	775
Arsenic	0.34 B
Barium	21.8
Beryllium	0.054 B
Chromium	1.1
Copper	1.9 B
Iron	565
Lead	7.9
Manganese	24.3
Mercury	0.0069
Nickel	0.27 B
Vanadium	1.1 B
Zinc	21.2

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds Median Background Limit

Exceeds Earthworm and Plant Limits

0 80 160

Feet

DATE DRAWN: 5/7/08	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-7
Ecological
Metal Surface Soil Distribution Map

FALCON REFINERY
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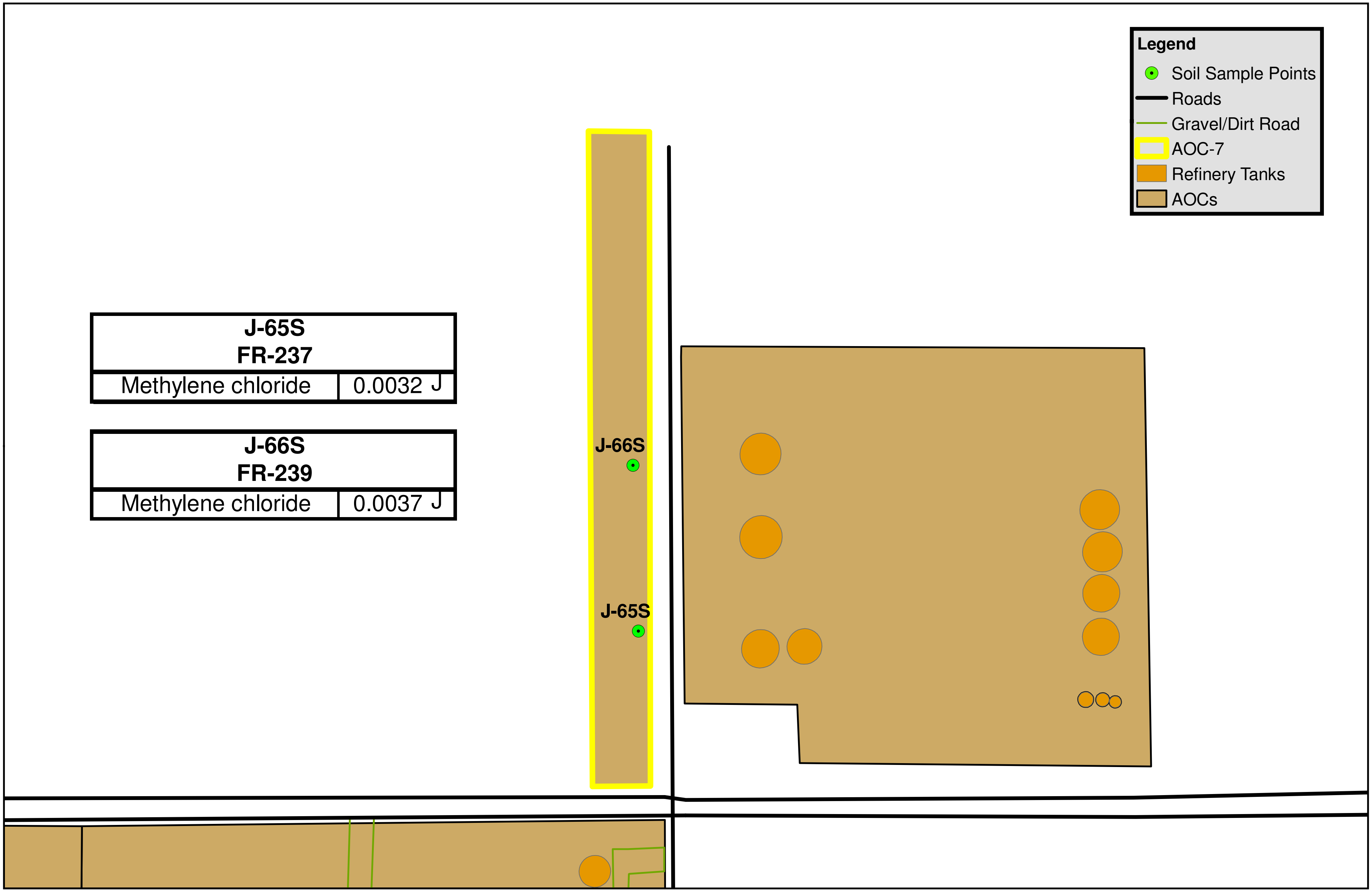
FIGURE
37A



Notes:

1. Results are posted in mg/kg

2. Qualifiers:

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

DATE DRAWN: 5/7/08	DATE REVISED: 4/1/09
DRAFTED BY: C. SEATON	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-7
Ecological
VOC Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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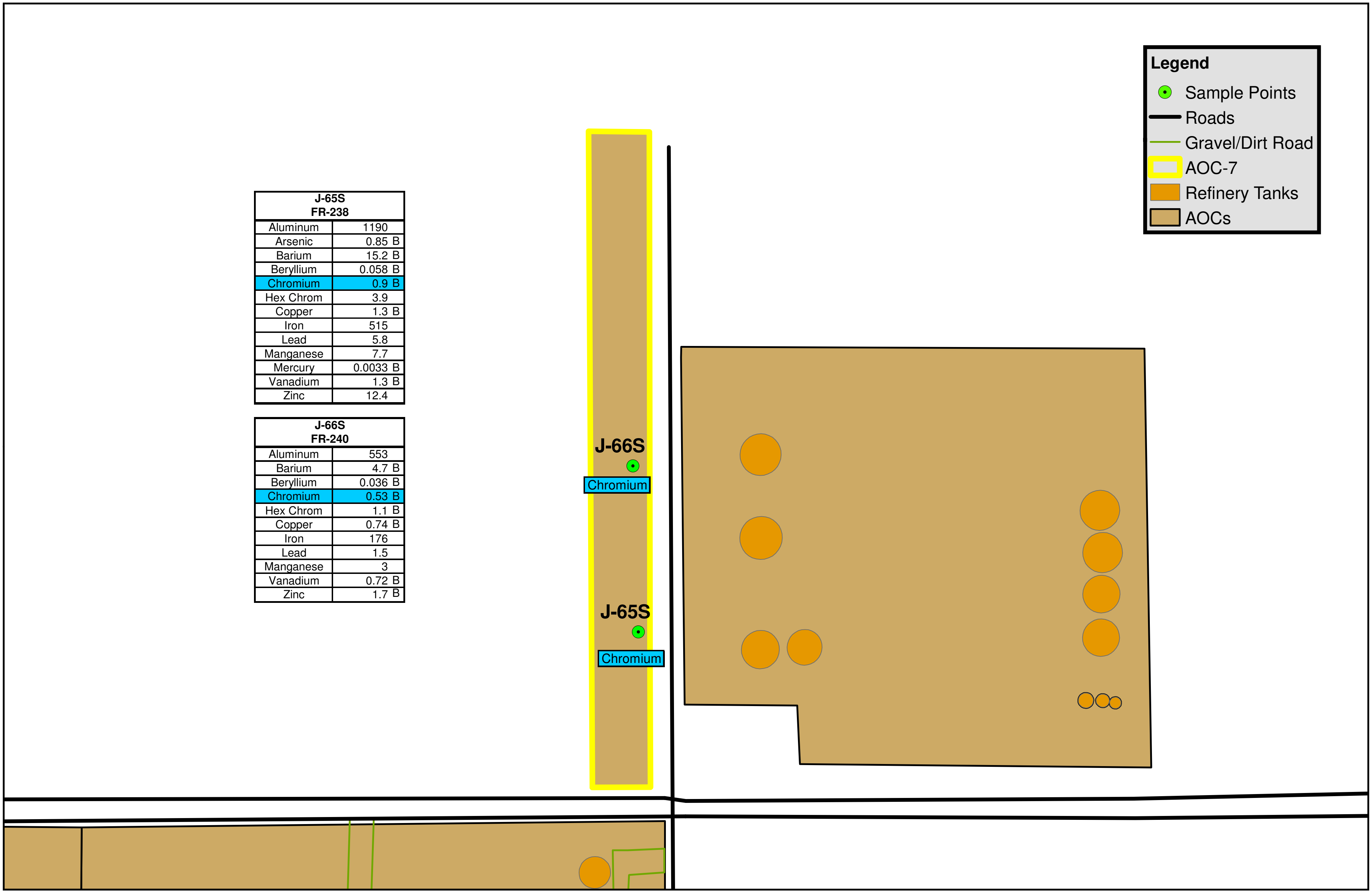
FIGURE
37B



J-65S FR-238	
Aluminum	1190
Arsenic	0.85 B
Barium	15.2 B
Beryllium	0.058 B
Chromium	0.9 B
Hex Chrom	3.9
Copper	1.3 B
Iron	515
Lead	5.8
Manganese	7.7
Mercury	0.0033 B
Vanadium	1.3 B
Zinc	12.4

J-66S FR-240	
Aluminum	553
Barium	4.7 B
Beryllium	0.036 B
Chromium	0.53 B
Hex Chrom	1.1 B
Copper	0.74 B
Iron	176
Lead	1.5
Manganese	3
Vanadium	0.72 B
Zinc	1.7 B

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds Earthworm Limit

N

0 90 180

Feet

DATE DRAWN: 5/7/08	DATE REVISED: 4/1/09
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CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-7
Ecological
Metal Subsurface Soil Distribution Map

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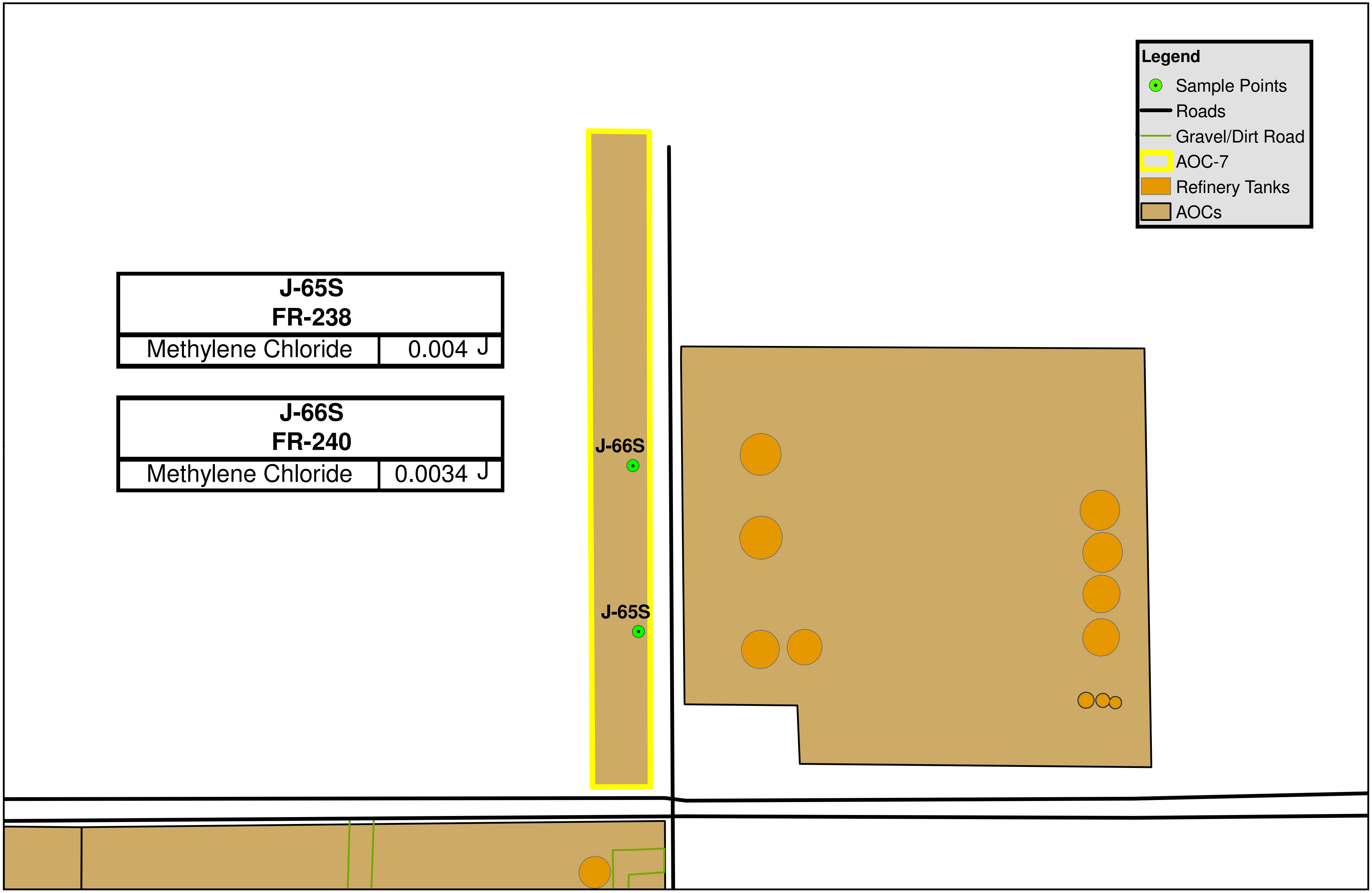
FIGURE
38A



Notes:

1. Results are posted in mg/kg

2. Qualifiers:

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

DATE DRAWN:	DATE REVISED:
5/7/08	4/1/09
DRAFTED BY: C. SEATON	
CHECKED BY: S. HALASZ	
APPROVED BY:	

AOC-7
Ecological
VOC Subsurface Soil Distribution Map

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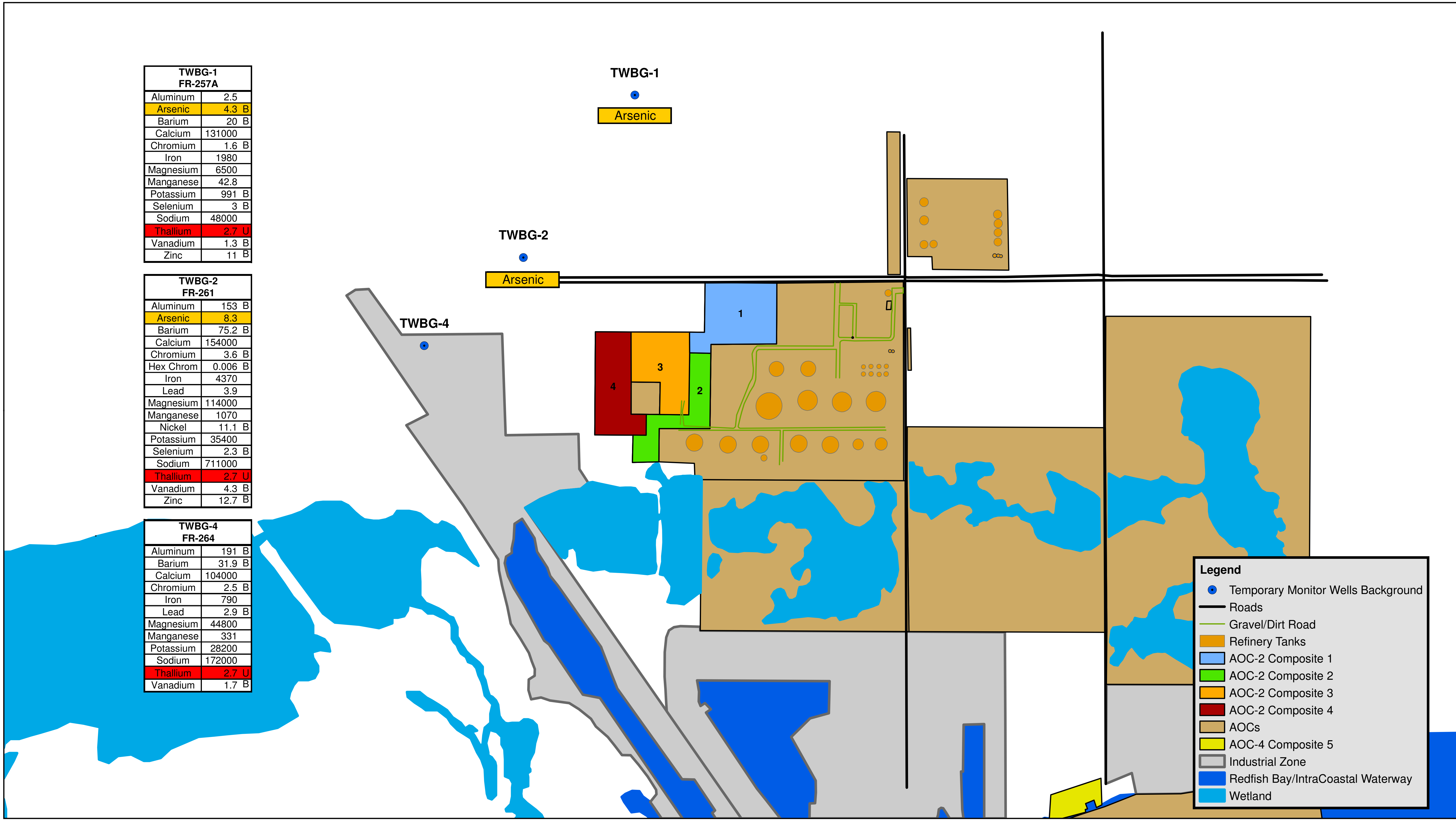
FIGURE
38B



TWBG-1 FR-257A		
Aluminum	2.5	
Arsenic	4.3	B
Barium	20	B
Calcium	131000	
Chromium	1.6	B
Iron	1980	
Magnesium	6500	
Manganese	42.8	
Potassium	991	B
Selenium	3	B
Sodium	48000	
Thallium	2.7	U
Vanadium	1.3	B
Zinc	11	B

TWBG-2 FR-261		
Aluminum	153	B
Arsenic	8.3	
Barium	75.2	B
Calcium	154000	
Chromium	3.6	B
Hex Chrom	0.006	B
Iron	4370	
Lead	3.9	
Magnesium	114000	
Manganese	1070	
Nickel	11.1	B
Potassium	35400	
Selenium	2.3	B
Sodium	711000	
Thallium	2.7	U
Vanadium	4.3	B
Zinc	12.7	B

TWBG-4 FR-264		
Aluminum	191	B
Barium	31.9	B
Calcium	104000	
Chromium	2.5	B
Iron	790	
Lead	2.9	B
Magnesium	44800	
Manganese	331	
Potassium	28200	
Sodium	172000	
Thallium	2.7	U
Vanadium	1.7	B

Notes:

1. Results are posted in mg/l
2. Qualifiers:

   U = Undetected at the sample detection limit (SDL)

   B = Analyte found in associated method blank

Exceeds EPA Region 6 MSSL or MCL If Available

SDL Exceeds Both EPA and TCEQ Screening Level

N

0 400 800

Feet

DATE DRAWN: 4/1/09	DATE REVISED:
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

Background Human Health Metal Groundwater Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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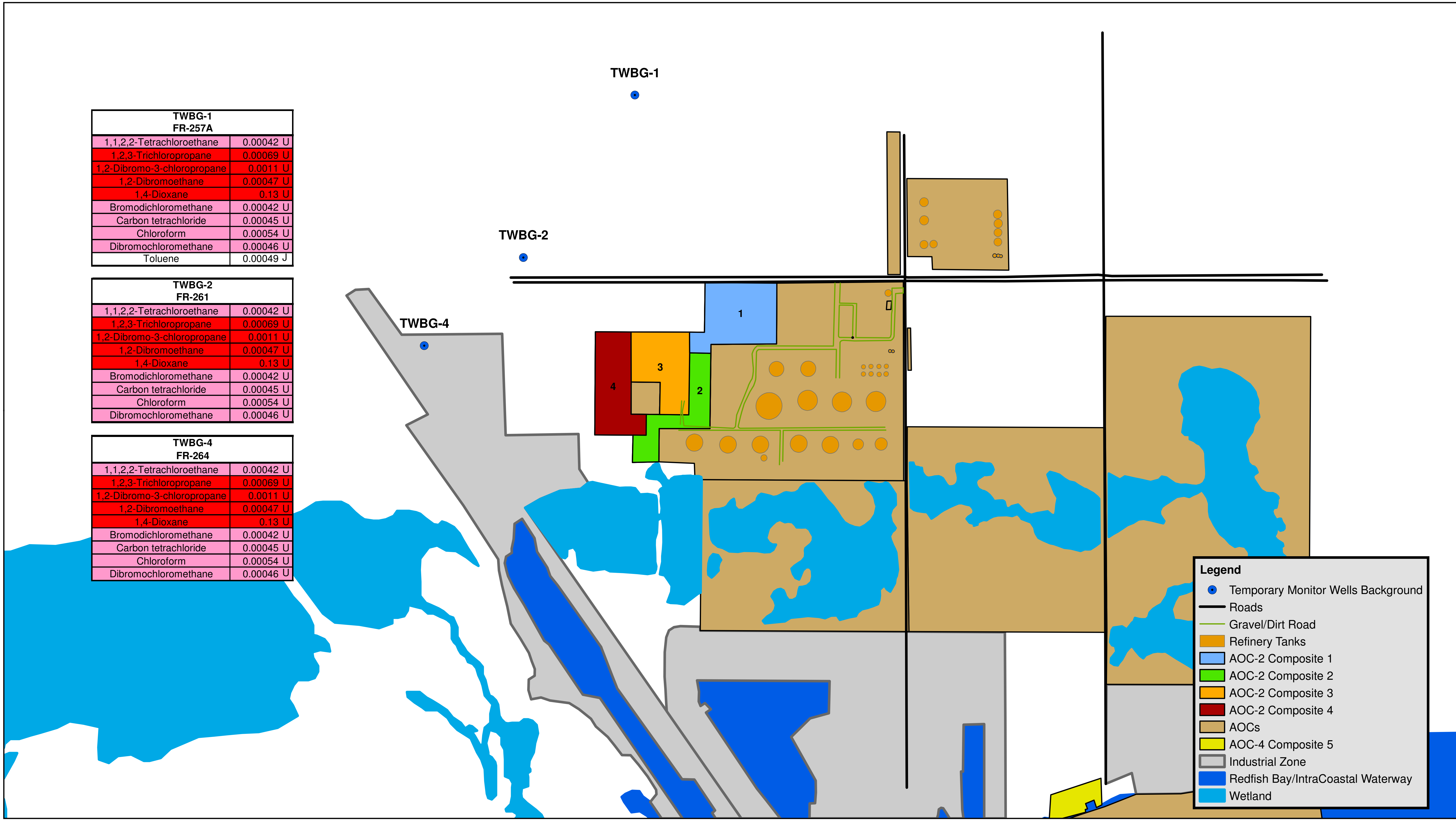
FIGURE

39A



TWBG-1 FR-257A	
1,1,2,2-Tetrachloroethane	0.00042 U
1,2,3-Trichloropropane	0.00069 U
1,2-Dibromo-3-chloropropane	0.0011 U
1,2-Dibromoethane	0.00047 U
1,4-Dioxane	0.13 U
Bromodichloromethane	0.00042 U
Carbon tetrachloride	0.00045 U
Chloroform	0.00054 U
Dibromochloromethane	0.00046 U
Toluene	0.00049 J

TWBG-2 FR-261	
1,1,2,2-Tetrachloroethane	0.00042 U
1,2,3-Trichloropropane	0.00069 U
1,2-Dibromo-3-chloropropane	0.0011 U
1,2-Dibromoethane	0.00047 U
1,4-Dioxane	0.13 U
Bromodichloromethane	0.00042 U
Carbon tetrachloride	0.00045 U
Chloroform	0.00054 U
Dibromochloromethane	0.00046 U

TWBG-4 FR-264	
1,1,2,2-Tetrachloroethane	0.00042 U
1,2,3-Trichloropropane	0.00069 U
1,2-Dibromo-3-chloropropane	0.0011 U
1,2-Dibromoethane	0.00047 U
1,4-Dioxane	0.13 U
Bromodichloromethane	0.00042 U
Carbon tetrachloride	0.00045 U
Chloroform	0.00054 U
Dibromochloromethane	0.00046 U

Notes:

1. Results are posted in mg/l

2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

SDL Exceeds EPA Screening Level or MCL If Available

SDL Exceeds Both EPA and TCEQ Screening Level

N

0 400 800

Feet

DATE DRAWN: 4/1/09	DATE REVISED:
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

Background Human Health VOC Groundwater Distribution Map

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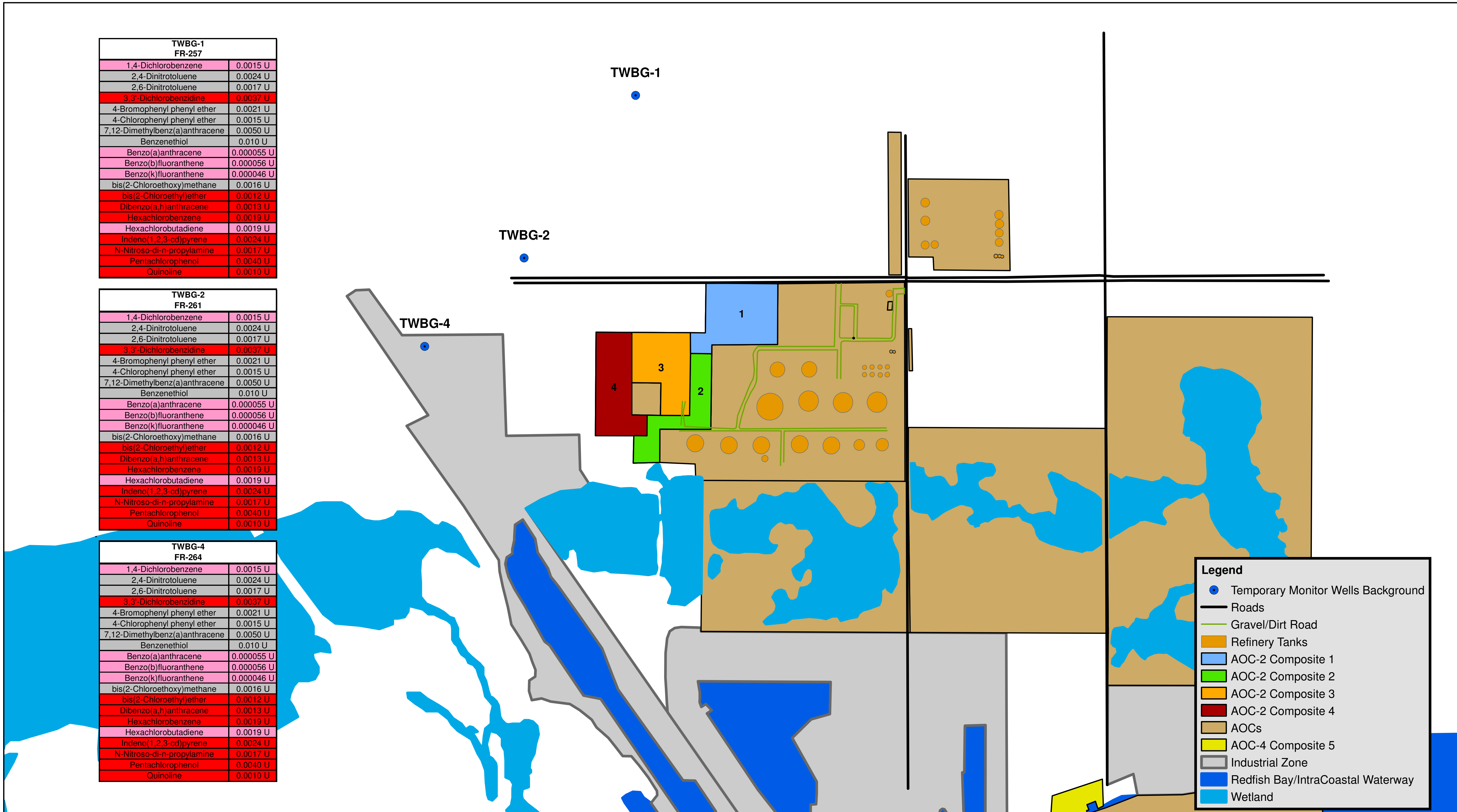
FIGURE

39B



TWBG-1 FR-257	
1,4-Dichlorobenzene	0.0015 U
2,4-Dinitrotoluene	0.0024 U
2,6-Dinitrotoluene	0.0017 U
3,3'-Dichlorobenzidine	0.0037 U
4-Bromophenyl phenyl ether	0.0021 U
4-Chlorophenyl phenyl ether	0.0015 U
7,12-Dimethylbenz(a)anthracene	0.0050 U
Benzenethiol	0.010 U
Benzo(a)anthracene	0.000055 U
Benzo(b)fluoranthene	0.000056 U
Benzo(k)fluoranthene	0.000046 U
bis(2-Chloroethoxy)methane	0.0016 U
bis(2-Chloroethyl)ether	0.0012 U
Dibenzo(a,h)anthracene	0.0013 U
Hexachlorobenzene	0.0019 U
Hexachlorobutadiene	0.0019 U
Indeno(1,2,3-cd)pyrene	0.0024 U
N-Nitroso-di-n-propylamine	0.0017 U
Pentachlorophenol	0.0040 U
Quinoline	0.0010 U

TWBG-2 FR-261	
1,4-Dichlorobenzene	0.0015 U
2,4-Dinitrotoluene	0.0024 U
2,6-Dinitrotoluene	0.0017 U
3,3'-Dichlorobenzidine	0.0037 U
4-Bromophenyl phenyl ether	0.0021 U
4-Chlorophenyl phenyl ether	0.0015 U
7,12-Dimethylbenz(a)anthracene	0.0050 U
Benzenethiol	0.010 U
Benzo(a)anthracene	0.000055 U
Benzo(b)fluoranthene	0.000056 U
Benzo(k)fluoranthene	0.000046 U
bis(2-Chloroethoxy)methane	0.0016 U
bis(2-Chloroethyl)ether	0.0012 U
Dibenzo(a,h)anthracene	0.0013 U
Hexachlorobenzene	0.0019 U
Hexachlorobutadiene	0.0019 U
Indeno(1,2,3-cd)pyrene	0.0024 U
N-Nitroso-di-n-propylamine	0.0017 U
Pentachlorophenol	0.0040 U
Quinoline	0.0010 U

TWBG-4 FR-264	
1,4-Dichlorobenzene	0.0015 U
2,4-Dinitrotoluene	0.0024 U
2,6-Dinitrotoluene	0.0017 U
3,3'-Dichlorobenzidine	0.0037 U
4-Bromophenyl phenyl ether	0.0021 U
4-Chlorophenyl phenyl ether	0.0015 U
7,12-Dimethylbenz(a)anthracene	0.0050 U
Benzenethiol	0.010 U
Benzo(a)anthracene	0.000055 U
Benzo(b)fluoranthene	0.000056 U
Benzo(k)fluoranthene	0.000046 U
bis(2-Chloroethoxy)methane	0.0016 U
bis(2-Chloroethyl)ether	0.0012 U
Dibenzo(a,h)anthracene	0.0013 U
Hexachlorobenzene	0.0019 U
Hexachlorobutadiene	0.0019 U
Indeno(1,2,3-cd)pyrene	0.0024 U
N-Nitroso-di-n-propylamine	0.0017 U
Pentachlorophenol	0.0040 U
Quinoline	0.0010 U

Notes:

1. Results are posted in mg/l
2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

SDL Exceeds EPA Screening Level or MCL If Available
SDL Exceeds TCEQ Screening Level
SDL Exceeds Both EPA and TCEQ Screening Level

N

0 325 650
Feet

DATE DRAWN: 4/1/09	DATE REVISED:
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CHECKED BY:	S. HALASZ
APPROVED BY:	

Background Human Health SVOC Groundwater Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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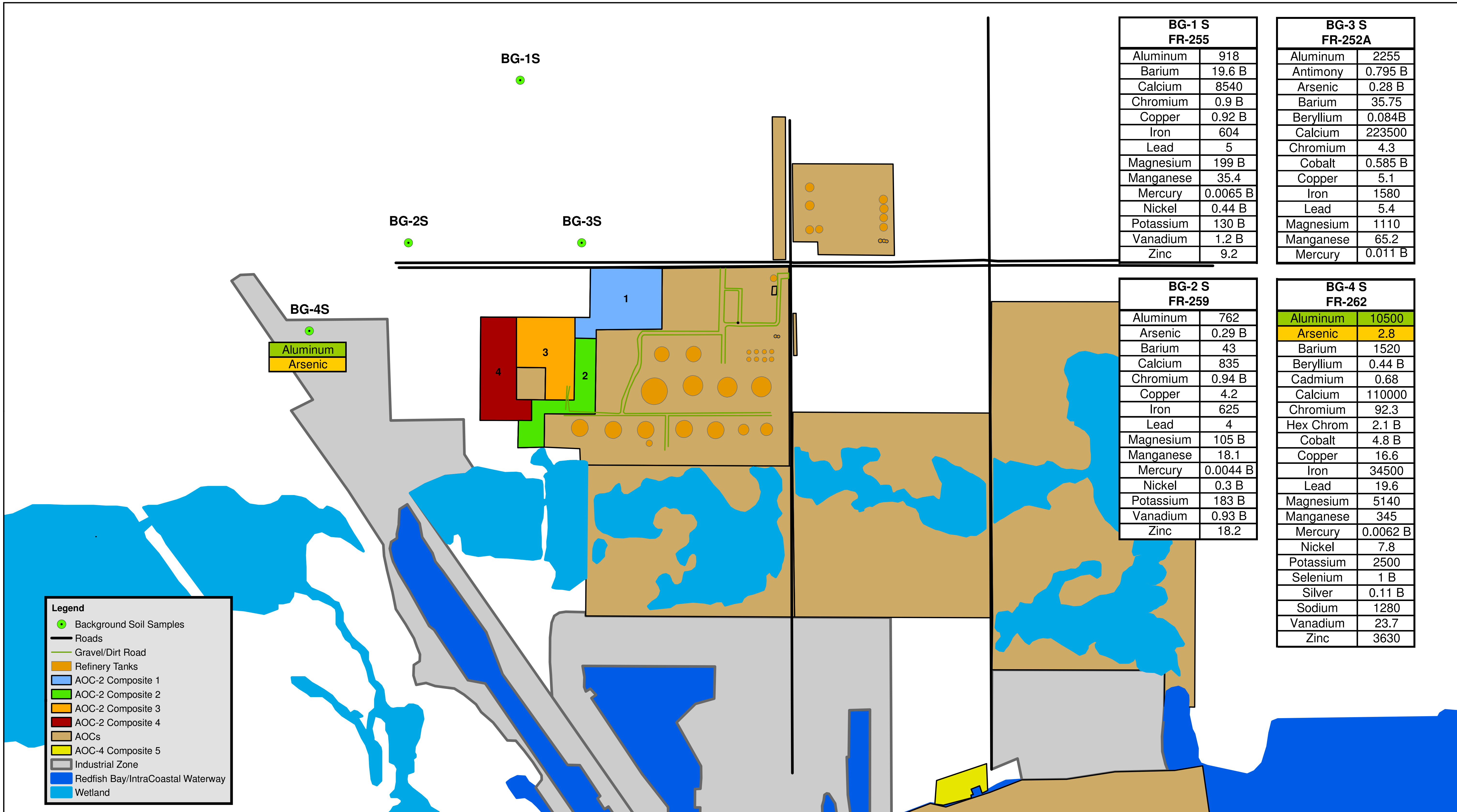
FIGURE
39C



BG-1 S FR-255	
Aluminum	918
Barium	19.6 B
Calcium	8540
Chromium	0.9 B
Copper	0.92 B
Iron	604
Lead	5
Magnesium	199 B
Manganese	35.4
Mercury	0.0065 B
Nickel	0.44 B
Potassium	130 B
Vanadium	1.2 B
Zinc	9.2

BG-3 S FR-252A	
Aluminum	2255
Antimony	0.795 B
Arsenic	0.28 B
Barium	35.75
Beryllium	0.084B
Calcium	223500
Chromium	4.3
Cobalt	0.585 B
Copper	5.1
Iron	1580
Lead	5.4
Magnesium	1110
Manganese	65.2
Mercury	0.011 B

BG-2 S FR-259	
Aluminum	762
Arsenic	0.29 B
Barium	43
Calcium	835
Chromium	0.94 B
Copper	4.2
Iron	625
Lead	4
Magnesium	105 B
Manganese	18.1
Mercury	0.0044 B
Nickel	0.3 B
Potassium	183 B
Vanadium	0.93 B
Zinc	18.2

BG-4 S FR-262	
Aluminum	10500
Arsenic	2.8
Barium	1520
Beryllium	0.44 B
Cadmium	0.68
Calcium	110000
Chromium	92.3
Hex Chrom	2.1 B
Cobalt	4.8 B
Copper	16.6
Iron	34500
Lead	19.6
Magnesium	5140
Manganese	345
Mercury	0.0062 B
Nickel	7.8
Potassium	2500
Selenium	1 B
Silver	0.11 B
Sodium	1280
Vanadium	23.7
Zinc	3630

Notes:

1. Results are posted in mg/kg

2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds EPA Region 6 MSSL

Exceeds TCEQ Tier 1 Residential PCL

N

0 400 800

Feet

DATE DRAWN: 4/1/09	DATE REVISED:
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

Background Human Health Metal Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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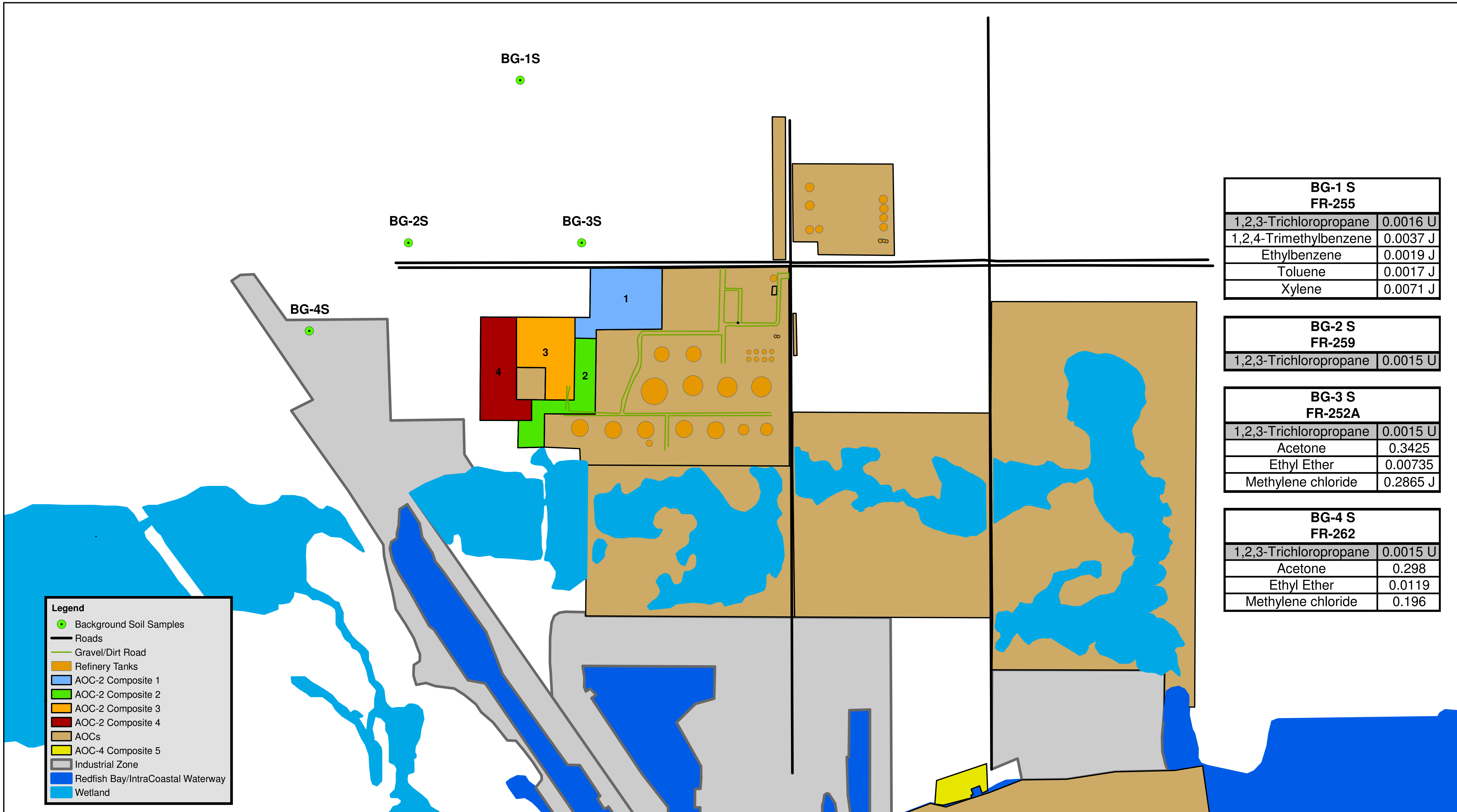
FIGURE 40A



BG-1 S FR-255	
1,2,3-Trichloropropane	0.0016 U
1,2,4-Trimethylbenzene	0.0037 J
Ethylbenzene	0.0019 J
Toluene	0.0017 J
Xylene	0.0071 J

BG-2 S FR-259	
1,2,3-Trichloropropane	0.0015 U

BG-3 S FR-252A	
1,2,3-Trichloropropane	0.0015 U
Acetone	0.3425
Ethyl Ether	0.00735
Methylene chloride	0.2865 J

BG-4 S FR-262	
1,2,3-Trichloropropane	0.0015 U
Acetone	0.298
Ethyl Ether	0.0119
Methylene chloride	0.196

SDL Exceeds TCEQ Screening Level

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

DATE DRAWN: 4/1/09	DATE REVISED:
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

Background Human Health VOC Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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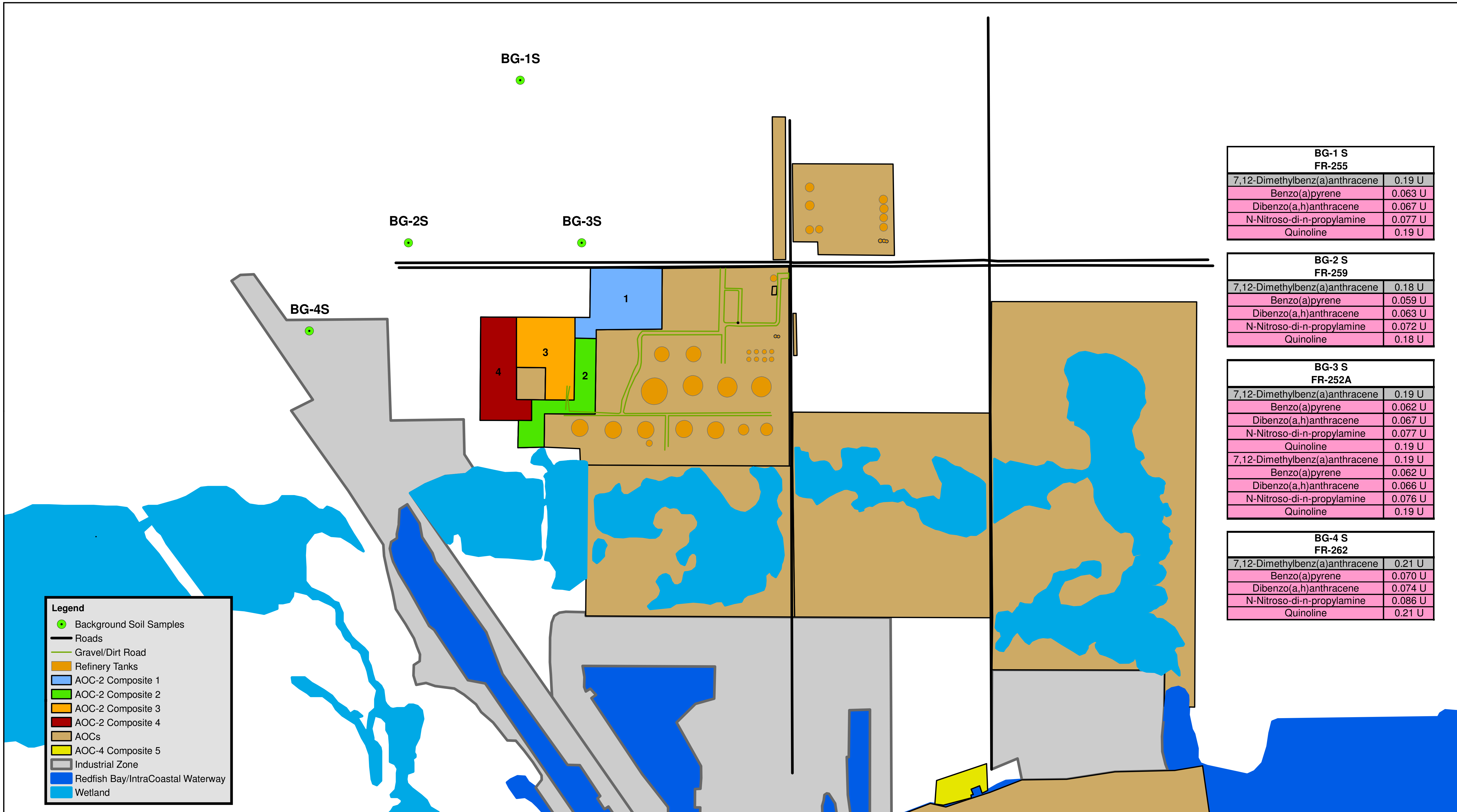
FIGURE **40B**



BG-1 S FR-255	
7,12-Dimethylbenz(a)anthracene	0.19 U
Benzo(a)pyrene	0.063 U
Dibenzo(a,h)anthracene	0.067 U
N-Nitroso-di-n-propylamine	0.077 U
Quinoline	0.19 U

BG-2 S FR-259	
7,12-Dimethylbenz(a)anthracene	0.18 U
Benzo(a)pyrene	0.059 U
Dibenzo(a,h)anthracene	0.063 U
N-Nitroso-di-n-propylamine	0.072 U
Quinoline	0.18 U

BG-3 S FR-252A	
7,12-Dimethylbenz(a)anthracene	0.19 U
Benzo(a)pyrene	0.062 U
Dibenzo(a,h)anthracene	0.067 U
N-Nitroso-di-n-propylamine	0.077 U
Quinoline	0.19 U
7,12-Dimethylbenz(a)anthracene	0.19 U
Benzo(a)pyrene	0.062 U
Dibenzo(a,h)anthracene	0.066 U
N-Nitroso-di-n-propylamine	0.076 U
Quinoline	0.19 U

BG-4 S FR-262	
7,12-Dimethylbenz(a)anthracene	0.21 U
Benzo(a)pyrene	0.070 U
Dibenzo(a,h)anthracene	0.074 U
N-Nitroso-di-n-propylamine	0.086 U
Quinoline	0.21 U

Notes:

1. Results are posted in mg/kg

2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

SDL Exceeds EPA Screening Level

SDL Exceeds TCEQ Screening Level

DATE DRAWN: 4/1/09	DATE REVISED:
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

Background Human Health SVOC Surface Soil Distribution Map

FALCON REFINERY
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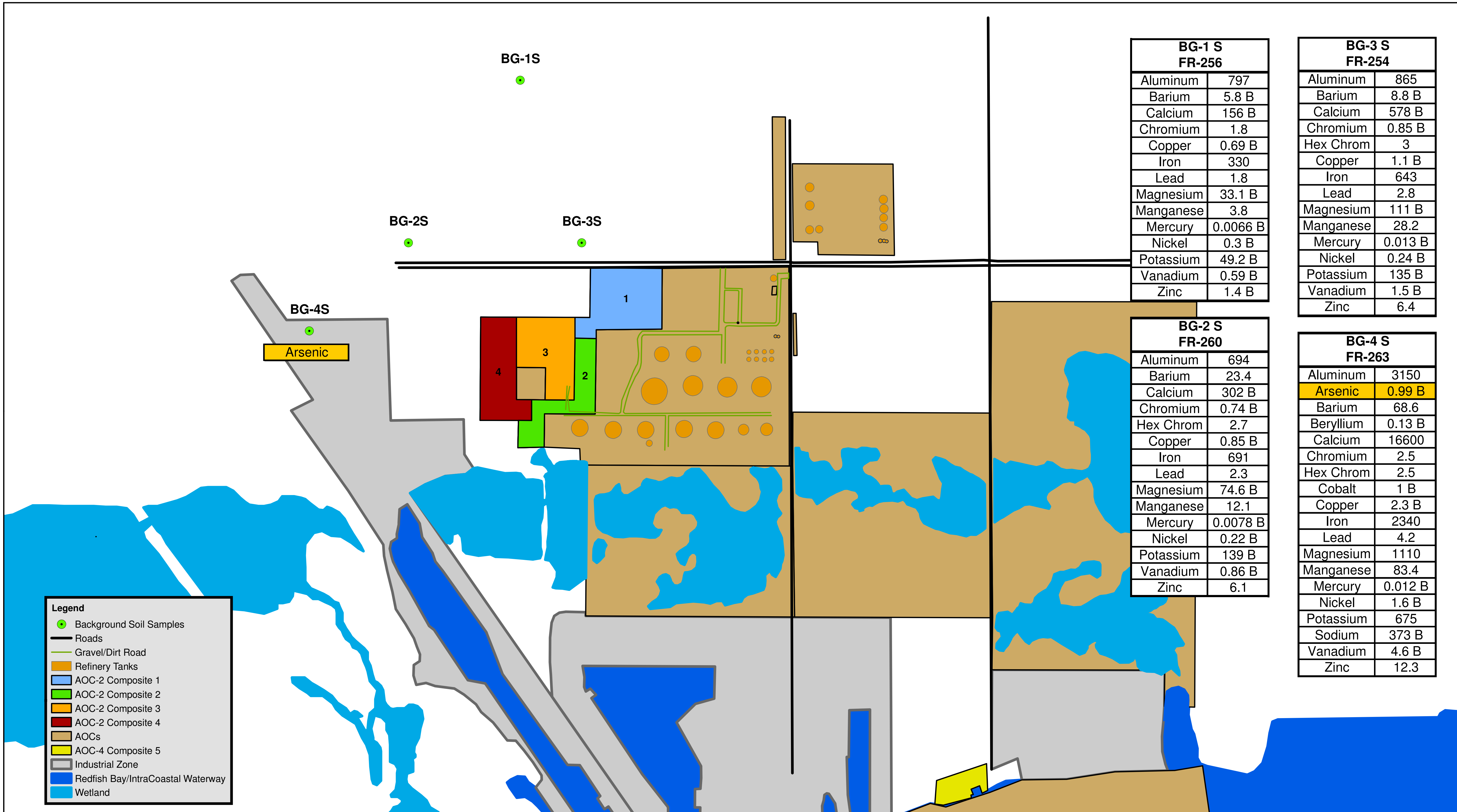
FIGURE
40C



BG-1 S FR-256	
Aluminum	797
Barium	5.8 B
Calcium	156 B
Chromium	1.8
Copper	0.69 B
Iron	330
Lead	1.8
Magnesium	33.1 B
Manganese	3.8
Mercury	0.0066 B
Nickel	0.3 B
Potassium	49.2 B
Vanadium	0.59 B
Zinc	1.4 B

BG-2 S FR-260	
Aluminum	694
Barium	23.4
Calcium	302 B
Chromium	0.74 B
Hex Chrom	2.7
Copper	0.85 B
Iron	691
Lead	2.3
Magnesium	74.6 B
Manganese	12.1
Mercury	0.0078 B
Nickel	0.22 B
Potassium	139 B
Vanadium	0.86 B
Zinc	6.1

BG-3 S FR-254	
Aluminum	865
Barium	8.8 B
Calcium	578 B
Chromium	0.85 B
Hex Chrom	3
Copper	1.1 B
Iron	643
Lead	2.8
Magnesium	111 B
Manganese	28.2
Mercury	0.013 B
Nickel	0.24 B
Potassium	135 B
Vanadium	1.5 B
Zinc	6.4

BG-4 S FR-263	
Aluminum	3150
Arsenic	0.99 B
Barium	68.6
Beryllium	0.13 B
Calcium	16600
Chromium	2.5
Hex Chrom	2.5
Cobalt	1 B
Copper	2.3 B
Iron	2340
Lead	4.2
Magnesium	1110
Manganese	83.4
Mercury	0.012 B
Nickel	1.6 B
Potassium	675
Sodium	373 B
Vanadium	4.6 B
Zinc	12.3

Notes:

1. Results are posted in mg/kg

2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds EPA Region 6 MSSL

N

0 400 800

Feet

DATE DRAWN: 4/1/09	DATE REVISED:
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

Background Human Health Metal Subsurface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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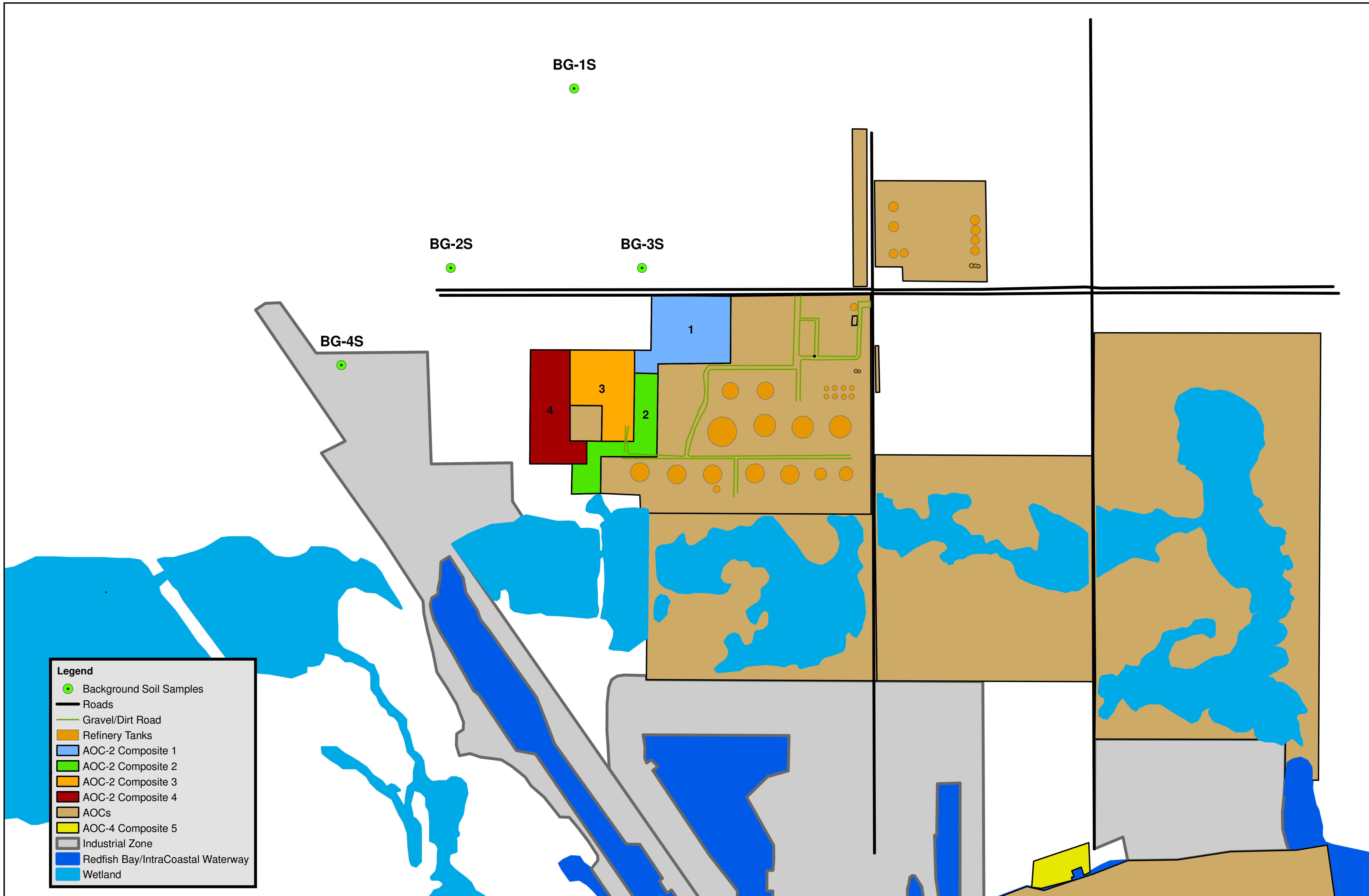
FIGURE

41A



BG-1 S FR-256	
1,2,3-Trichloropropane	0.0016 U
Acetone	0.413
Ethyl Ether	0.0078
Methylene chloride	0.132

BG-2 S FR-260	
1,2,3-Trichloropropane	0.0015 U
Acetone	0.237
Ethyl Ether	0.0054
Methylene chloride	0.0491

BG-3 S FR-254	
1,2,3-Trichloropropane	0.0016 U
Acetone	0.181
Ethyl Ether	0.0061
Methylene chloride	0.131

BG-4 S FR-263	
1,2,3-Trichloropropane	0.0015 U
Acetone	0.235
Ethyl Ether	0.0068
Methylene chloride	0.133

Notes:

1. Results are posted in mg/kg

2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

SDL Exceeds TCEQ Screening Level

N

0 400 800

Feet

DATE DRAWN: 4/1/09	DATE REVISED:
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

Background Human Health VOC Subsurface Soil Distribution Map

FALCON REFINERY
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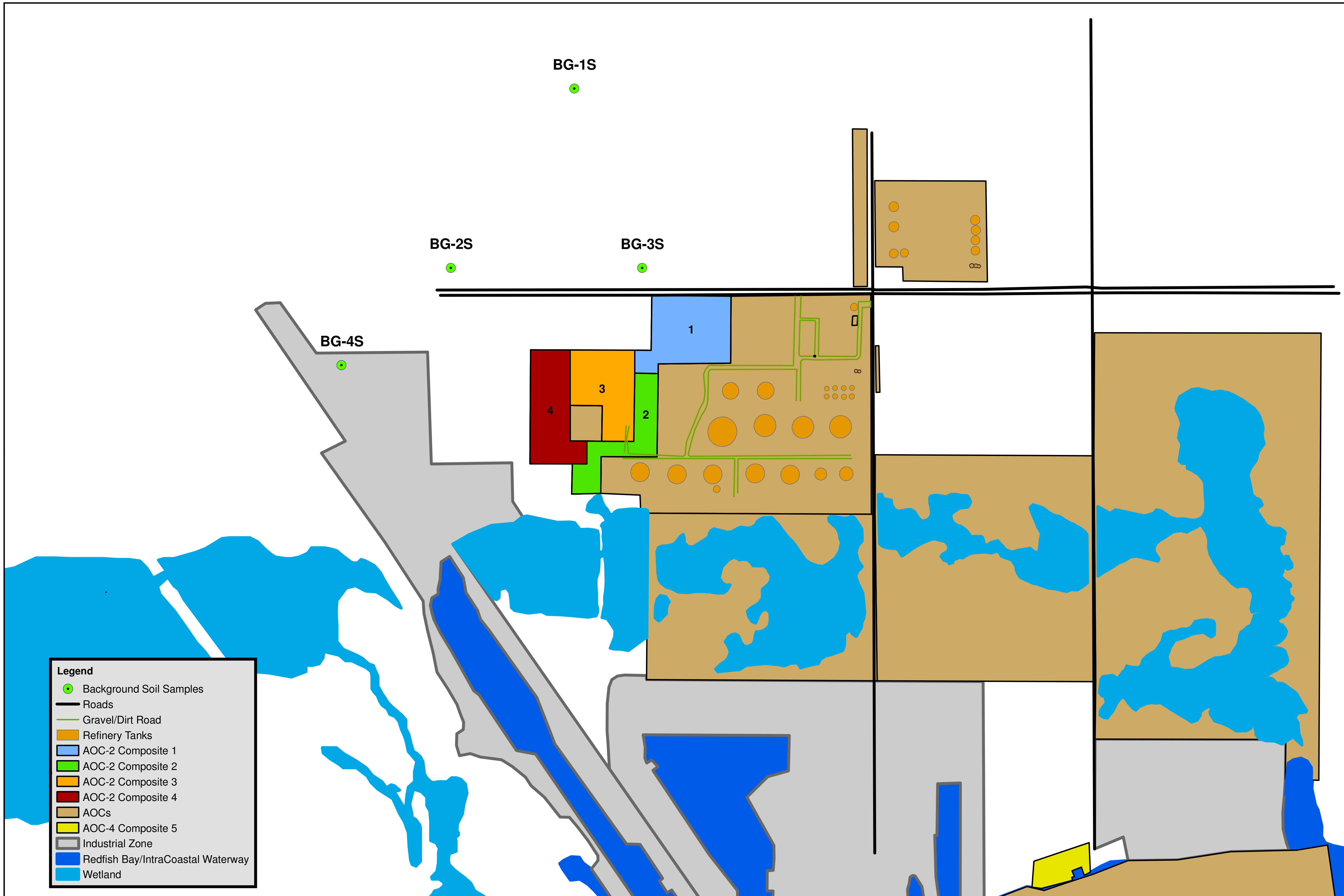
FIGURE
41B



BG-1 S FR-256	
7,12-Dimethylbenz(a)anthracene	0.19 U
Benzo(a)pyrene	0.063 U
Dibenzo(a,h)anthracene	0.067 U
N-Nitroso-di-n-propylamine	0.078 U
Quinoline	0.19 U

BG-2 S FR-260	
7,12-Dimethylbenz(a)anthracene	0.19 U
Benzo(a)pyrene	0.061 U
Dibenzo(a,h)anthracene	0.065 U
N-Nitroso-di-n-propylamine	0.075 U
Quinoline	0.19 U

BG-3 S FR-254	
7,12-Dimethylbenz(a)anthracene	0.21 U
Benzo(a)pyrene	0.068 U
Dibenzo(a,h)anthracene	0.072 U
N-Nitroso-di-n-propylamine	0.083 U
Quinoline	0.21 U

BG-4 S FR-263	
7,12-Dimethylbenz(a)anthracene	0.19 U
Benzo(a)pyrene	0.063 U
Dibenzo(a,h)anthracene	0.067 U
N-Nitroso-di-n-propylamine	0.078 U
Quinoline	0.19 U

Notes:

1. Results are posted in mg/kg

2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

SDL Exceeds EPA Screening Level

SDL Exceeds TCEQ Screening Level

N

0 400 800

Feet

DATE DRAWN: 4/1/09	DATE REVISED:
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

Background Human Health SVOC Subsurface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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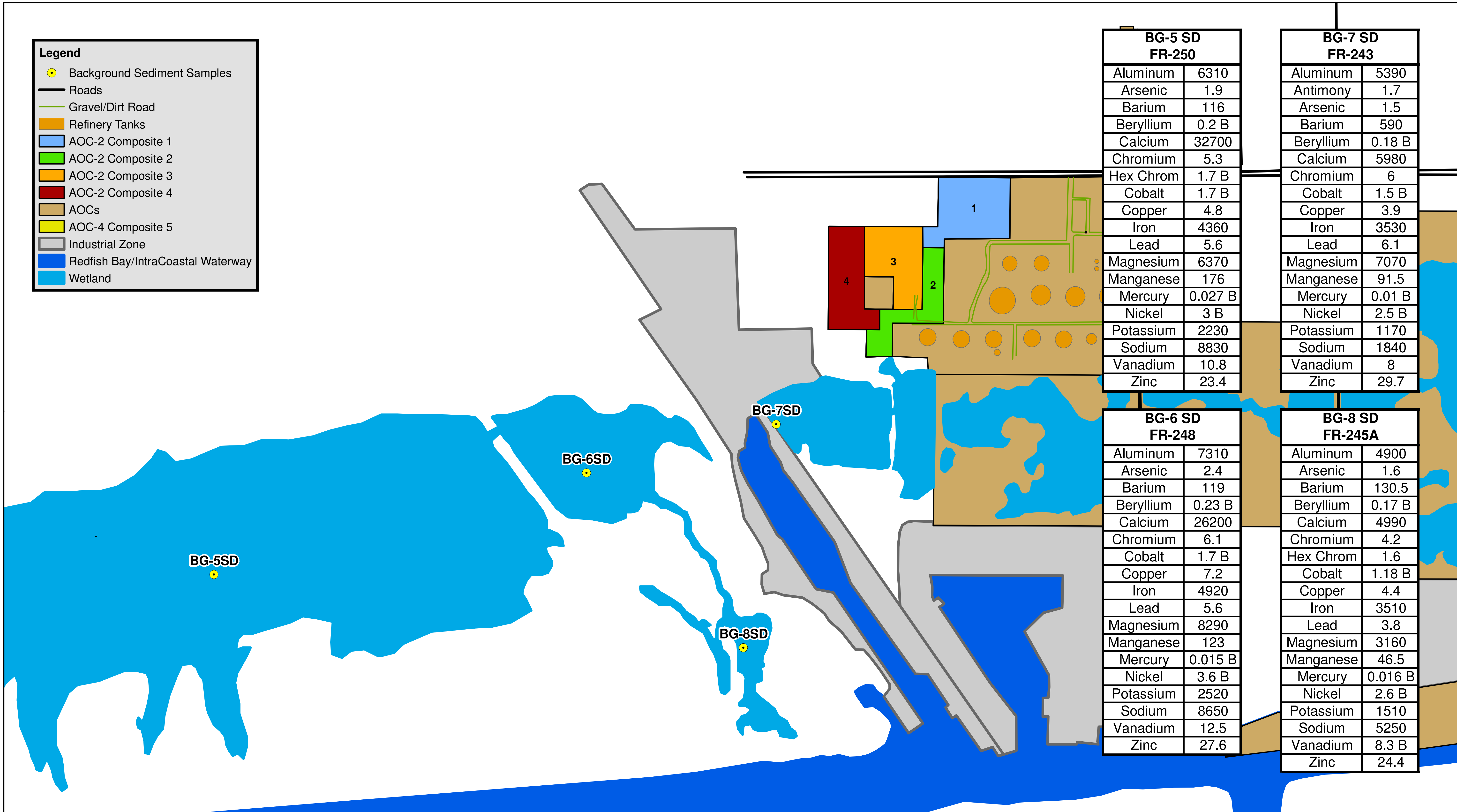
FIGURE
41C



BG-5 SD FR-250	
Aluminum	6310
Arsenic	1.9
Barium	116
Beryllium	0.2 B
Calcium	32700
Chromium	5.3
Hex Chrom	1.7 B
Cobalt	1.7 B
Copper	4.8
Iron	4360
Lead	5.6
Magnesium	6370
Manganese	176
Mercury	0.027 B
Nickel	3 B
Potassium	2230
Sodium	8830
Vanadium	10.8
Zinc	23.4

BG-7 SD FR-243	
Aluminum	5390
Antimony	1.7
Arsenic	1.5
Barium	590
Beryllium	0.18 B
Calcium	5980
Chromium	6
Cobalt	1.5 B
Copper	3.9
Iron	3530
Lead	6.1
Magnesium	7070
Manganese	91.5
Mercury	0.01 B
Nickel	2.5 B
Potassium	1170
Sodium	1840
Vanadium	8
Zinc	29.7

BG-6 SD FR-248	
Aluminum	7310
Arsenic	2.4
Barium	119
Beryllium	0.23 B
Calcium	26200
Chromium	6.1
Cobalt	1.7 B
Copper	7.2
Iron	4920
Lead	5.6
Magnesium	8290
Manganese	123
Mercury	0.015 B
Nickel	3.6 B
Potassium	2520
Sodium	8650
Vanadium	12.5
Zinc	27.6

BG-8 SD FR-245A	
Aluminum	4900
Arsenic	1.6
Barium	130.5
Beryllium	0.17 B
Calcium	4990
Chromium	4.2
Hex Chrom	1.6
Cobalt	1.18 B
Copper	4.4
Iron	3510
Lead	3.8
Magnesium	3160
Manganese	46.5
Mercury	0.016 B
Nickel	2.6 B
Potassium	1510
Sodium	5250
Vanadium	8.3 B
Zinc	24.4

Notes:

1. Results are posted in mg/kg

2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

N

0 350 700

Feet

DATE DRAWN: 4/1/09	DATE REVISED:
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

Background Human Health Metal Sediment Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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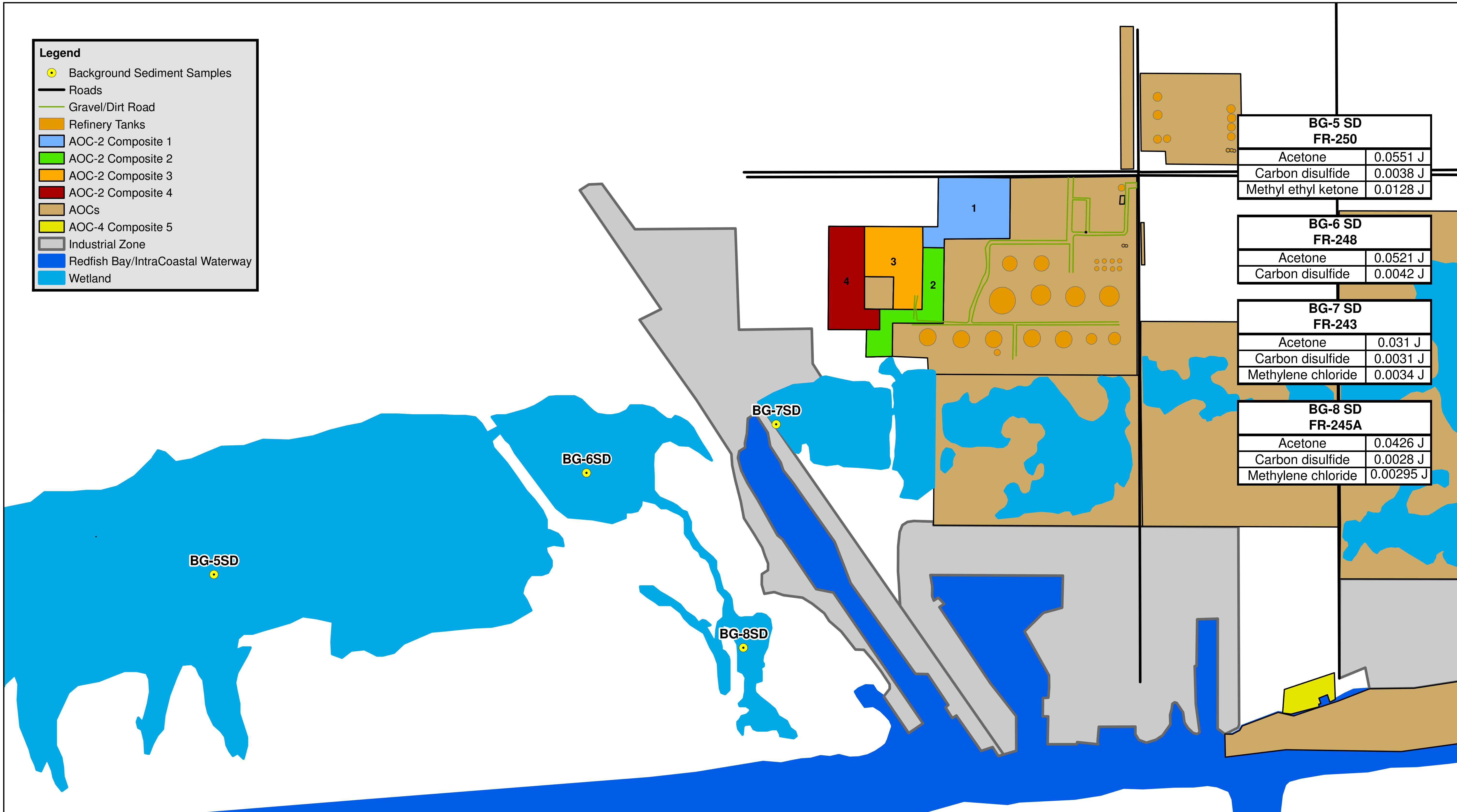
FIGURE **42A**



BG-5 SD FR-250	
Acetone	0.0551 J
Carbon disulfide	0.0038 J
Methyl ethyl ketone	0.0128 J

BG-6 SD FR-248	
Acetone	0.0521 J
Carbon disulfide	0.0042 J

BG-7 SD FR-243	
Acetone	0.031 J
Carbon disulfide	0.0031 J
Methylene chloride	0.0034 J

BG-8 SD FR-245A	
Acetone	0.0426 J
Carbon disulfide	0.0028 J
Methylene chloride	0.00295 J

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

N

0 350 700
Feet

DATE DRAWN: 4/1/09	DATE REVISED:
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CHECKED BY:	S. HALASZ
APPROVED BY:	

Background Human Health VOC Sediment Distribution Map

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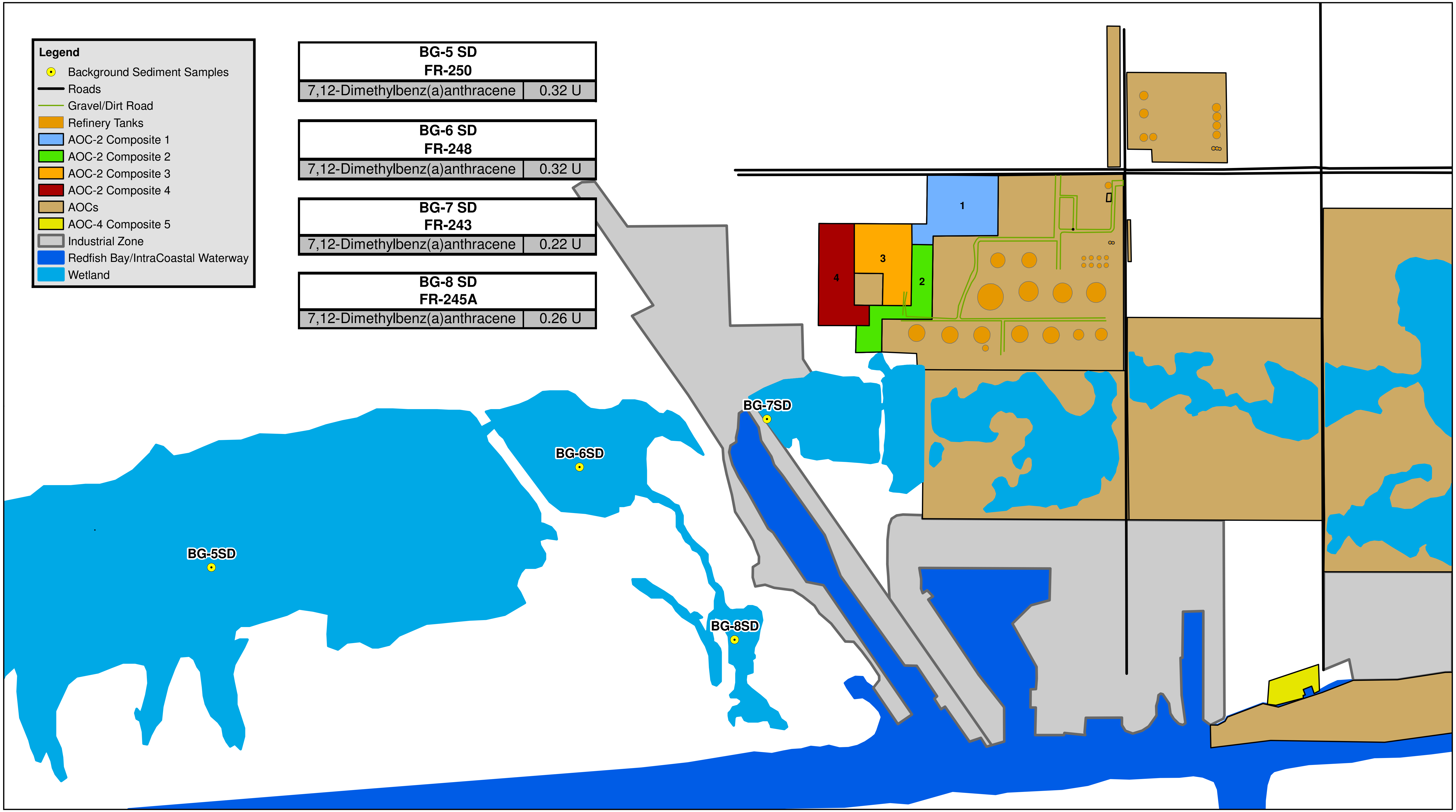
FIGURE
42B



Notes:

1. Results are posted in mg/kg

2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

SDL Exceeds TCEQ Screening Level

N

0 350 700

Feet

DATE DRAWN: 4/1/09	DATE REVISED:
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APPROVED BY:	

Background Human Health SVOC Sediment Distribution Map

FALCON REFINERY
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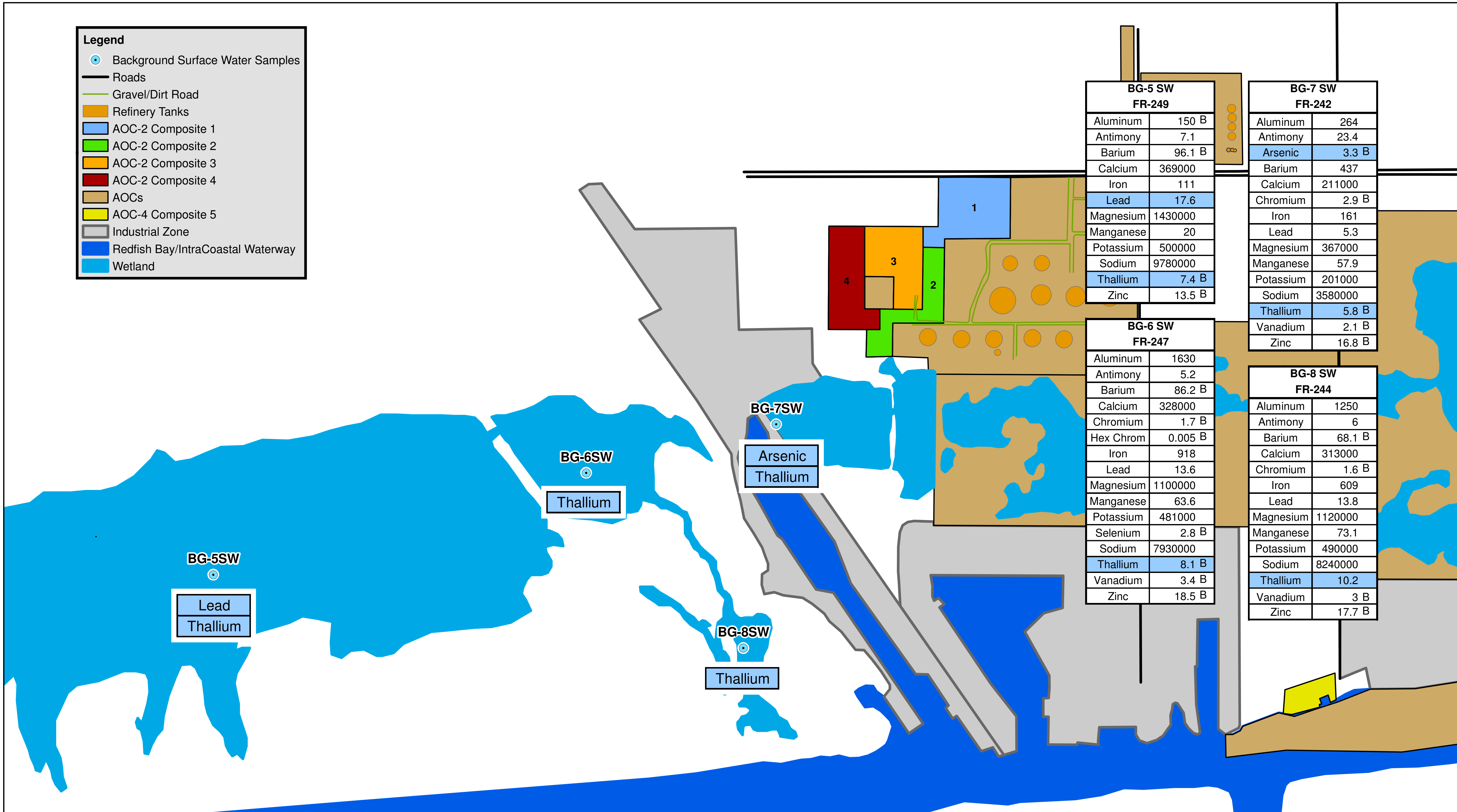
FIGURE
42C



BG-5 SW FR-249	
Aluminum	150 B
Antimony	7.1
Barium	96.1 B
Calcium	369000
Iron	111
Lead	17.6
Magnesium	1430000
Manganese	20
Potassium	500000
Sodium	9780000
Thallium	7.4 B
Zinc	13.5 B

BG-6 SW FR-247	
Aluminum	1630
Antimony	5.2
Barium	86.2 B
Calcium	328000
Chromium	1.7 B
Hex Chrom	0.005 B
Iron	918
Lead	13.6
Magnesium	1100000
Manganese	63.6
Potassium	481000
Selenium	2.8 B
Sodium	7930000
Thallium	8.1 B
Vanadium	3.4 B
Zinc	18.5 B

BG-7 SW FR-242	
Aluminum	264
Antimony	23.4
Arsenic	3.3 B
Barium	437
Calcium	211000
Chromium	2.9 B
Iron	161
Lead	5.3
Magnesium	367000
Manganese	57.9
Potassium	201000
Sodium	3580000
Thallium	5.8 B
Vanadium	2.1 B
Zinc	16.8 B

BG-8 SW FR-244	
Aluminum	1250
Antimony	6
Barium	68.1 B
Calcium	313000
Chromium	1.6 B
Iron	609
Lead	13.8
Magnesium	1120000
Manganese	73.1
Potassium	490000
Sodium	8240000
Thallium	10.2
Vanadium	3 B
Zinc	17.7 B

Notes:

1. Results are posted in µg/l
Results for Hex Chrom in mg/l

2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds ^{SW}RBELs

N

0 350 700

Feet

DATE DRAWN: 4/1/09	DATE REVISED:
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

Background Human Health Metal Surface Water Distribution Map

FALCON REFINERY
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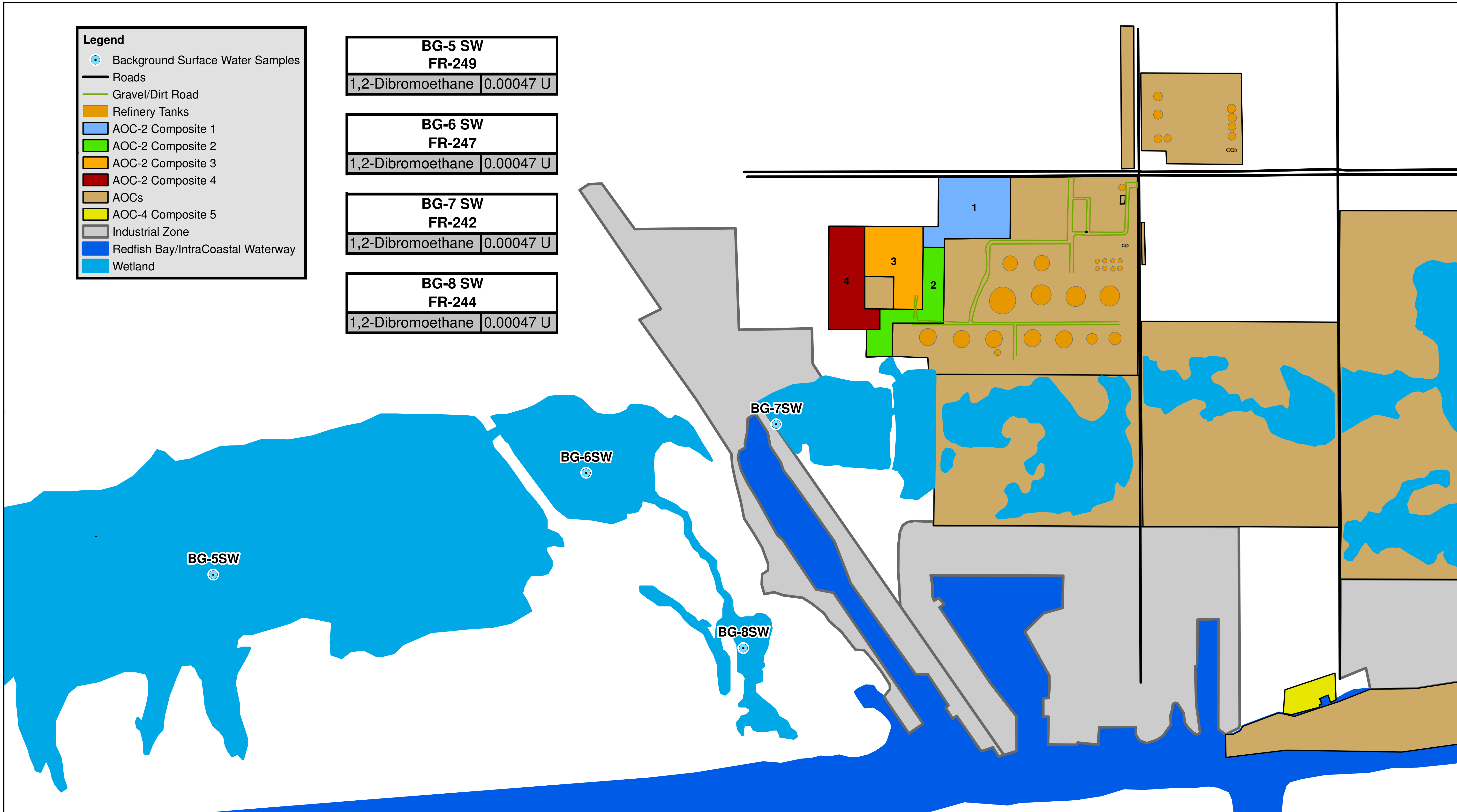
FIGURE
43A



Notes:

1. Results are posted in mg/l

2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

SDL Exceeds TCEQ Screening Level

N

0 400 800

Feet

DATE DRAWN: 4/1/09	DATE REVISED:
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Background Human Health VOC Surface Water Distribution Map

FALCON REFINERY
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PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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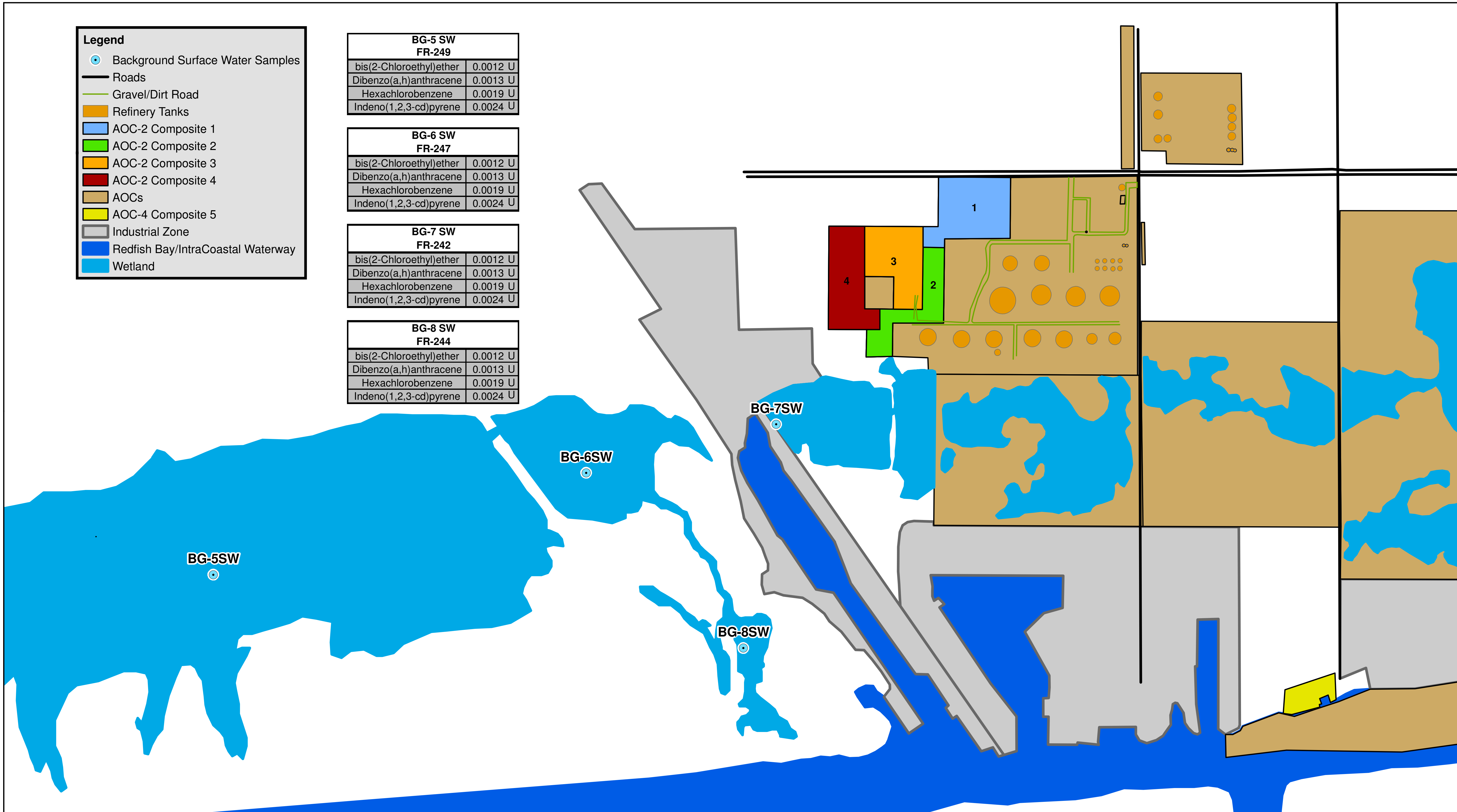
FIGURE
43B



BG-5 SW FR-249	
bis(2-Chloroethyl)ether	0.0012 U
Dibenzo(a,h)anthracene	0.0013 U
Hexachlorobenzene	0.0019 U
Indeno(1,2,3-cd)pyrene	0.0024 U

BG-6 SW FR-247	
bis(2-Chloroethyl)ether	0.0012 U
Dibenzo(a,h)anthracene	0.0013 U
Hexachlorobenzene	0.0019 U
Indeno(1,2,3-cd)pyrene	0.0024 U

BG-7 SW FR-242	
bis(2-Chloroethyl)ether	0.0012 U
Dibenzo(a,h)anthracene	0.0013 U
Hexachlorobenzene	0.0019 U
Indeno(1,2,3-cd)pyrene	0.0024 U

BG-8 SW FR-244	
bis(2-Chloroethyl)ether	0.0012 U
Dibenzo(a,h)anthracene	0.0013 U
Hexachlorobenzene	0.0019 U
Indeno(1,2,3-cd)pyrene	0.0024 U

Notes:

1. Results are posted in mg/l
2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

SDL Exceeds TCEQ Screening Level

N

0 400 800

Feet

DATE DRAWN: 4/1/09
DATE REVISED:
DRAFTED BY: C. SEATON
CHECKED BY: S. HALASZ
APPROVED BY:

Background Human Health SVOC Surface Water Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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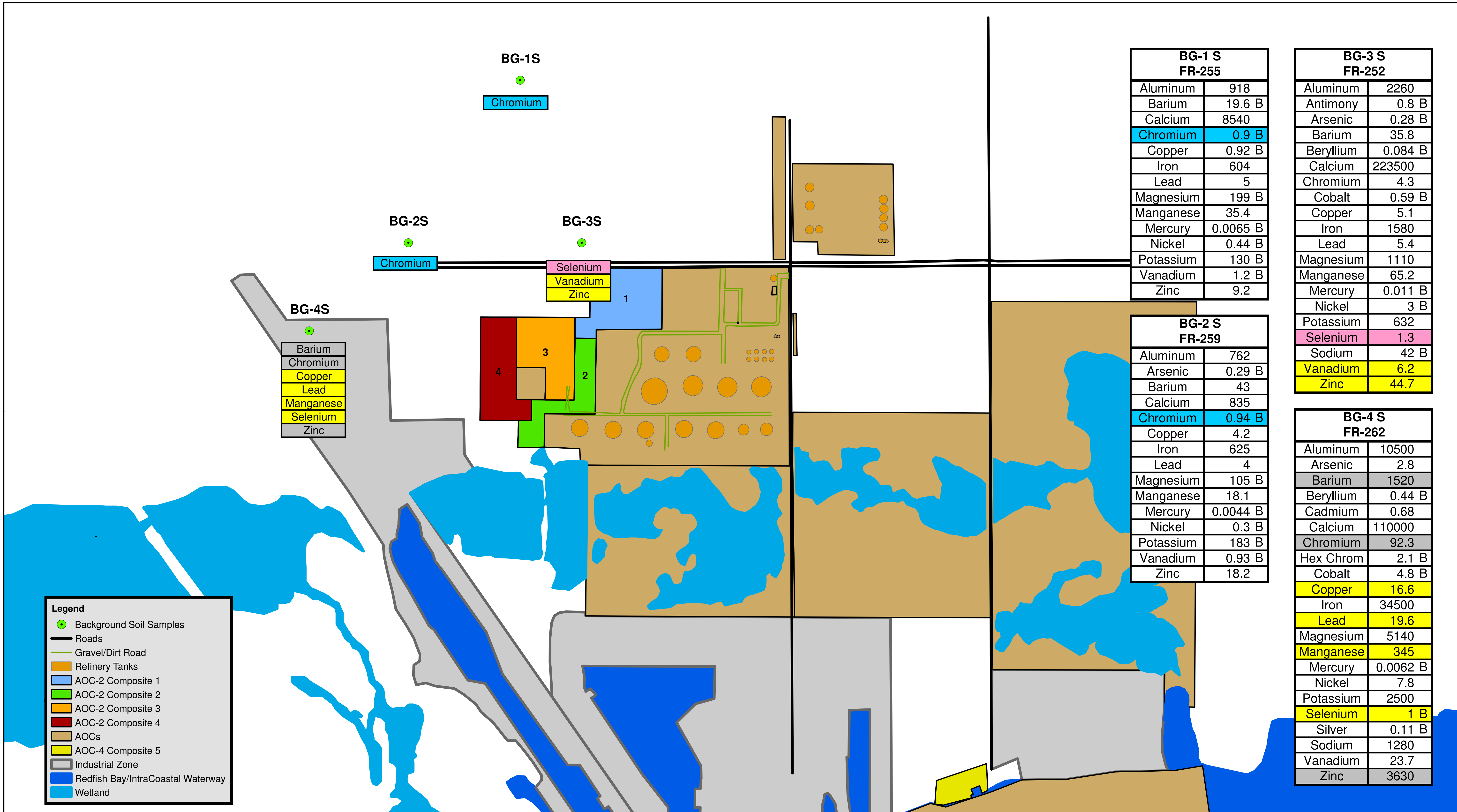
FIGURE 43C



BG-1 S FR-255	
Aluminum	918
Barium	19.6 B
Calcium	8540
Chromium	0.9 B
Copper	0.92 B
Iron	604
Lead	5
Magnesium	199 B
Manganese	35.4
Mercury	0.0065 B
Nickel	0.44 B
Potassium	130 B
Vanadium	1.2 B
Zinc	9.2

BG-2 S FR-259	
Aluminum	762
Arsenic	0.29 B
Barium	43
Calcium	835
Chromium	0.94 B
Copper	4.2
Iron	625
Lead	4
Magnesium	105 B
Manganese	18.1
Mercury	0.0044 B
Nickel	0.3 B
Potassium	183 B
Vanadium	0.93 B
Zinc	18.2

BG-3 S FR-252	
Aluminum	2260
Antimony	0.8 B
Arsenic	0.28 B
Barium	35.8
Beryllium	0.084 B
Calcium	223500
Chromium	4.3
Cobalt	0.59 B
Copper	5.1
Iron	1580
Lead	5.4
Magnesium	1110
Manganese	65.2
Mercury	0.011 B
Nickel	3 B
Potassium	632
Selenium	1.3
Sodium	42 B
Vanadium	6.2
Zinc	44.7

BG-4 S FR-262	
Aluminum	10500
Arsenic	2.8
Barium	1520
Beryllium	0.44 B
Cadmium	0.68
Calcium	110000
Chromium	92.3
Hex Chrom	2.1 B
Cobalt	4.8 B
Copper	16.6
Iron	34500
Lead	19.6
Magnesium	5140
Manganese	345
Mercury	0.0062 B
Nickel	7.8
Potassium	2500
Selenium	1 B
Silver	0.11 B
Sodium	1280
Vanadium	23.7
Zinc	3630

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds Earthworm Limit
Exceeds Median Background Limit
Exceeds Plant and Median Background Limits
Exceeds Earthworm, Plant, and Median Background Limits

N

0 350 700
Feet

DATE DRAWN: 4/1/09	DATE REVISED:
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

Background Ecological Metal Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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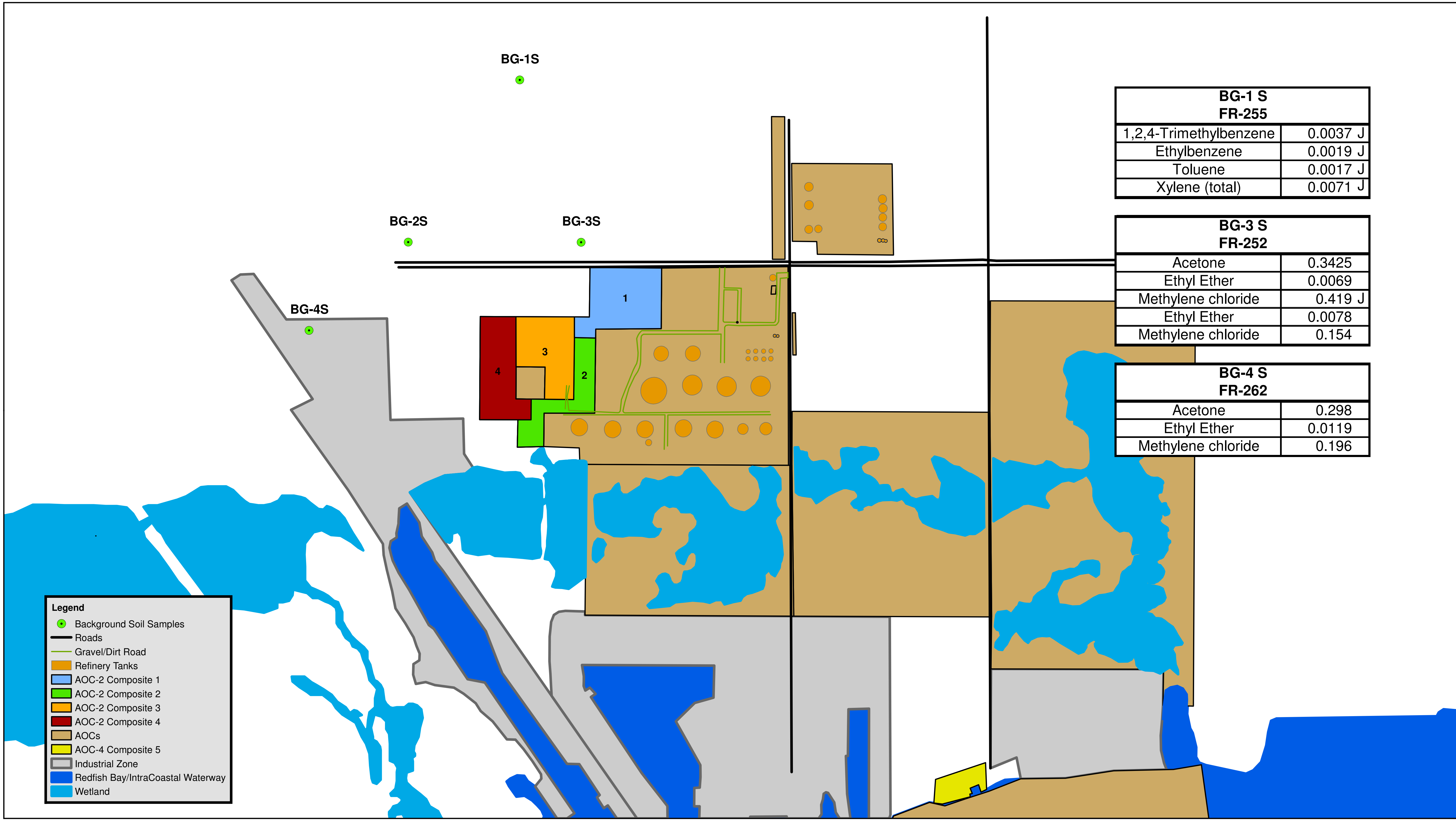
FIGURE
44A



BG-1 S FR-255	
1,2,4-Trimethylbenzene	0.0037 J
Ethylbenzene	0.0019 J
Toluene	0.0017 J
Xylene (total)	0.0071 J

BG-3 S FR-252	
Acetone	0.3425
Ethyl Ether	0.0069
Methylene chloride	0.419 J
Ethyl Ether	0.0078
Methylene chloride	0.154

BG-4 S FR-262	
Acetone	0.298
Ethyl Ether	0.0119
Methylene chloride	0.196

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

N

0 400 800
Feet

DATE DRAWN: 4/1/09	DATE REVISED:	
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CHECKED BY:	S. HALASZ	
APPROVED BY:		

Background Ecological VOC Surface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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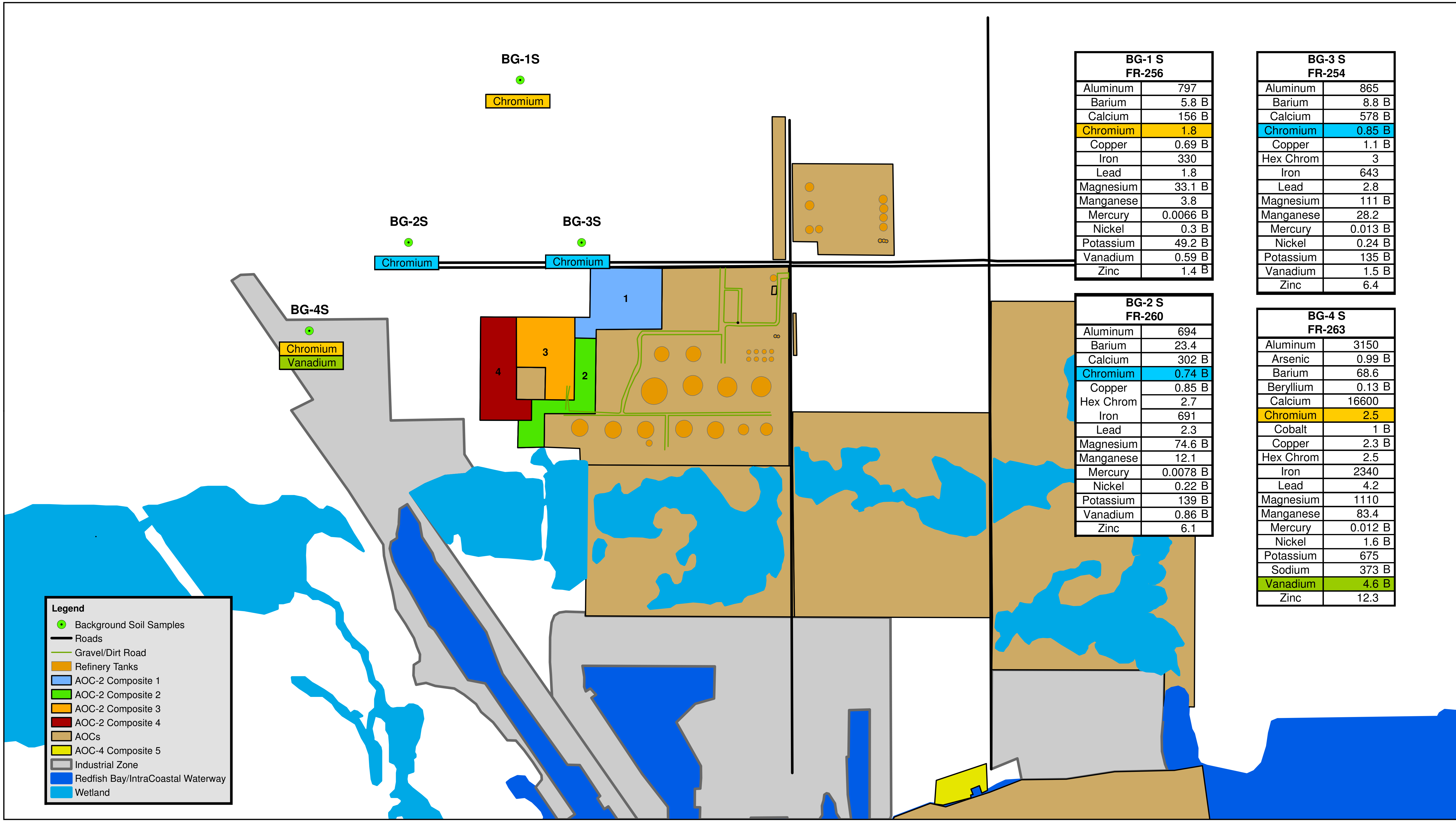
FIGURE
44B



BG-1 S FR-256	
Aluminum	797
Barium	5.8 B
Calcium	156 B
Chromium	1.8
Copper	0.69 B
Iron	330
Lead	1.8
Magnesium	33.1 B
Manganese	3.8
Mercury	0.0066 B
Nickel	0.3 B
Potassium	49.2 B
Vanadium	0.59 B
Zinc	1.4 B

BG-2 S FR-260	
Aluminum	694
Barium	23.4
Calcium	302 B
Chromium	0.74 B
Copper	0.85 B
Hex Chrom	2.7
Iron	691
Lead	2.3
Magnesium	74.6 B
Manganese	12.1
Mercury	0.0078 B
Nickel	0.22 B
Potassium	139 B
Vanadium	0.86 B
Zinc	6.1

BG-3 S FR-254	
Aluminum	865
Barium	8.8 B
Calcium	578 B
Chromium	0.85 B
Copper	1.1 B
Hex Chrom	3
Iron	643
Lead	2.8
Magnesium	111 B
Manganese	28.2
Mercury	0.013 B
Nickel	0.24 B
Potassium	135 B
Vanadium	1.5 B
Zinc	6.4

BG-4 S FR-263	
Aluminum	3150
Arsenic	0.99 B
Barium	68.6
Beryllium	0.13 B
Calcium	16600
Chromium	2.5
Cobalt	1 B
Copper	2.3 B
Hex Chrom	2.5
Iron	2340
Lead	4.2
Magnesium	1110
Manganese	83.4
Mercury	0.012 B
Nickel	1.6 B
Potassium	675
Sodium	373 B
Vanadium	4.6 B
Zinc	12.3

Notes:

1. Results are posted in mg/kg
2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Exceeds Earthworm Limit
Exceeds Plant Limit
Exceeds Earthworm and Plant Limits

N

0 350 700
Feet

DATE DRAWN: 4/1/09	DATE REVISED:
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

Background Ecological Metal Subsurface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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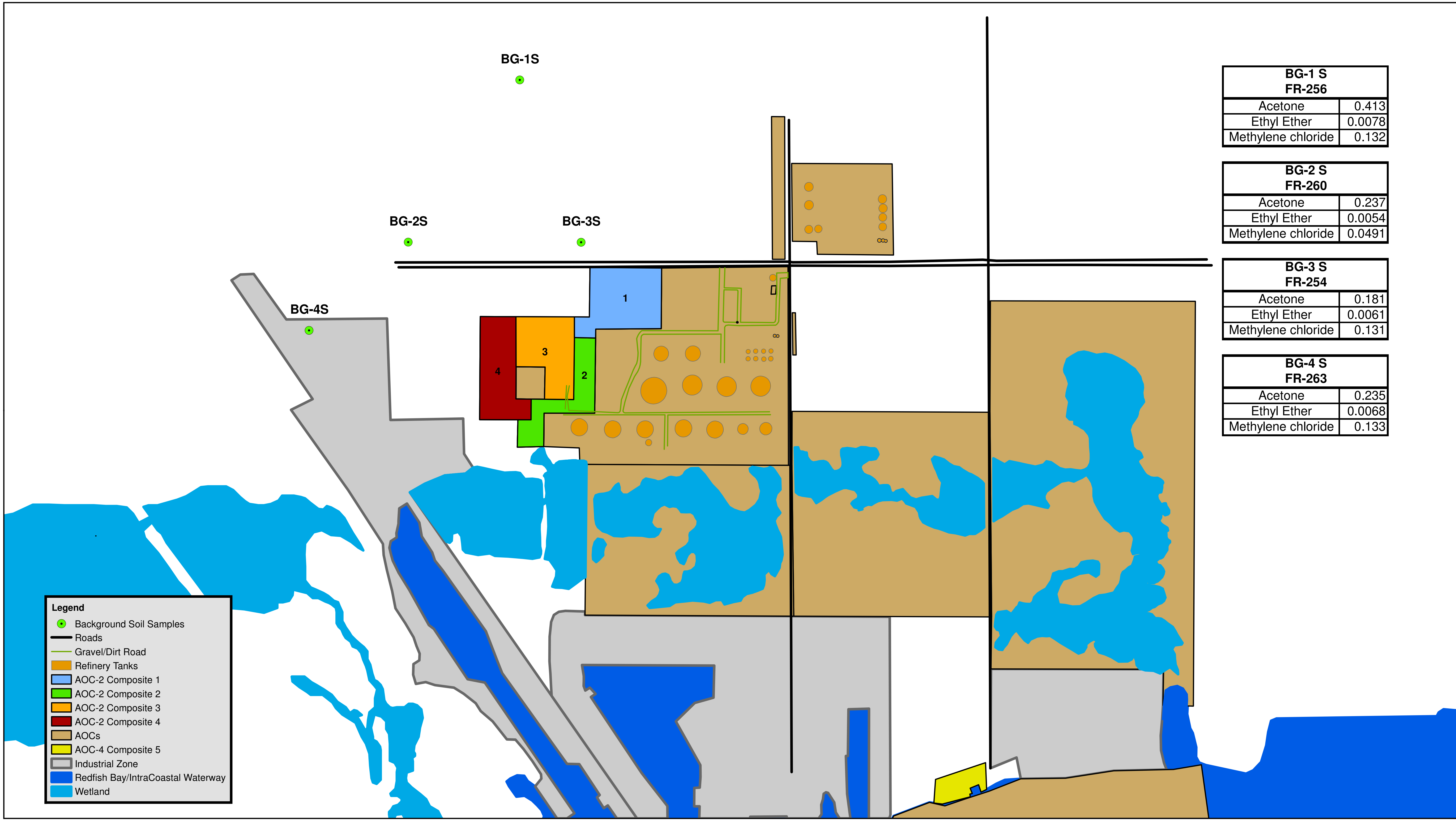
FIGURE
45A



BG-1 S FR-256	
Acetone	0.413
Ethyl Ether	0.0078
Methylene chloride	0.132

BG-2 S FR-260	
Acetone	0.237
Ethyl Ether	0.0054
Methylene chloride	0.0491

BG-3 S FR-254	
Acetone	0.181
Ethyl Ether	0.0061
Methylene chloride	0.131

BG-4 S FR-263	
Acetone	0.235
Ethyl Ether	0.0068
Methylene chloride	0.133

Notes:

1. Results are posted in mg/kg

N

0 400 800

Feet

DATE DRAWN: 4/1/09	DATE REVISED:
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

Background Ecological VOC Subsurface Soil Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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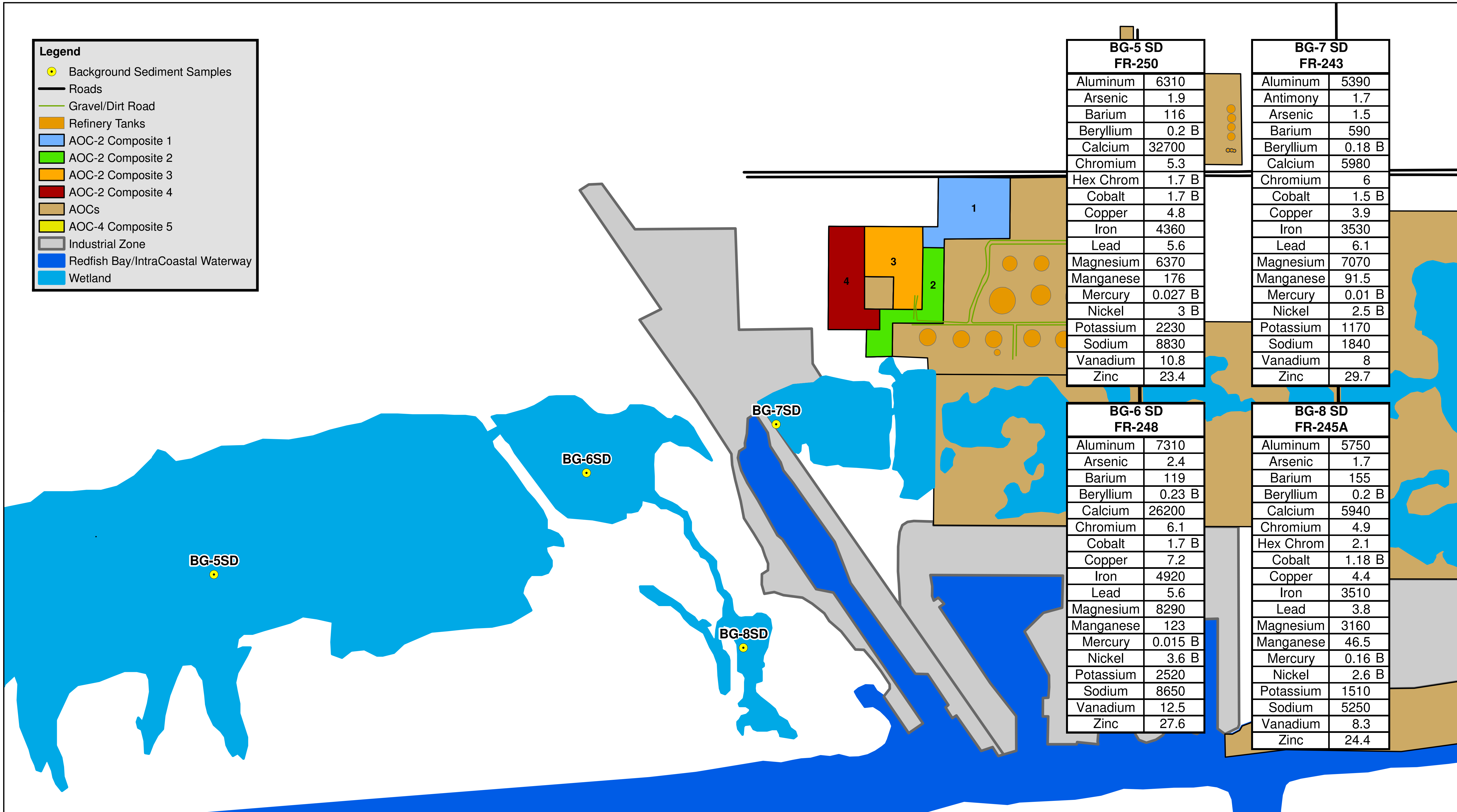
FIGURE

45B



BG-5 SD FR-250	
Aluminum	6310
Arsenic	1.9
Barium	116
Beryllium	0.2 B
Calcium	32700
Chromium	5.3
Hex Chrom	1.7 B
Cobalt	1.7 B
Copper	4.8
Iron	4360
Lead	5.6
Magnesium	6370
Manganese	176
Mercury	0.027 B
Nickel	3 B
Potassium	2230
Sodium	8830
Vanadium	10.8
Zinc	23.4

BG-7 SD FR-243	
Aluminum	5390
Antimony	1.7
Arsenic	1.5
Barium	590
Beryllium	0.18 B
Calcium	5980
Chromium	6
Cobalt	1.5 B
Copper	3.9
Iron	3530
Lead	6.1
Magnesium	7070
Manganese	91.5
Mercury	0.01 B
Nickel	2.5 B
Potassium	1170
Sodium	1840
Vanadium	8
Zinc	29.7

BG-6 SD FR-248	
Aluminum	7310
Arsenic	2.4
Barium	119
Beryllium	0.23 B
Calcium	26200
Chromium	6.1
Cobalt	1.7 B
Copper	7.2
Iron	4920
Lead	5.6
Magnesium	8290
Manganese	123
Mercury	0.015 B
Nickel	3.6 B
Potassium	2520
Sodium	8650
Vanadium	12.5
Zinc	27.6

BG-8 SD FR-245A	
Aluminum	5750
Arsenic	1.7
Barium	155
Beryllium	0.2 B
Calcium	5940
Chromium	4.9
Hex Chrom	2.1
Cobalt	1.18 B
Copper	4.4
Iron	3510
Lead	3.8
Magnesium	3160
Manganese	46.5
Mercury	0.16 B
Nickel	2.6 B
Potassium	1510
Sodium	5250
Vanadium	8.3
Zinc	24.4

Notes:

1. Results are posted in mg/kg

2. Qualifiers:

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

N

0 400 800

Feet

DATE DRAWN: 4/1/09	DATE REVISED:
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

Background Ecological Metal Sediment Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

PROJ NO. 59752 FILE NAME: Falcon Refinery Base Map

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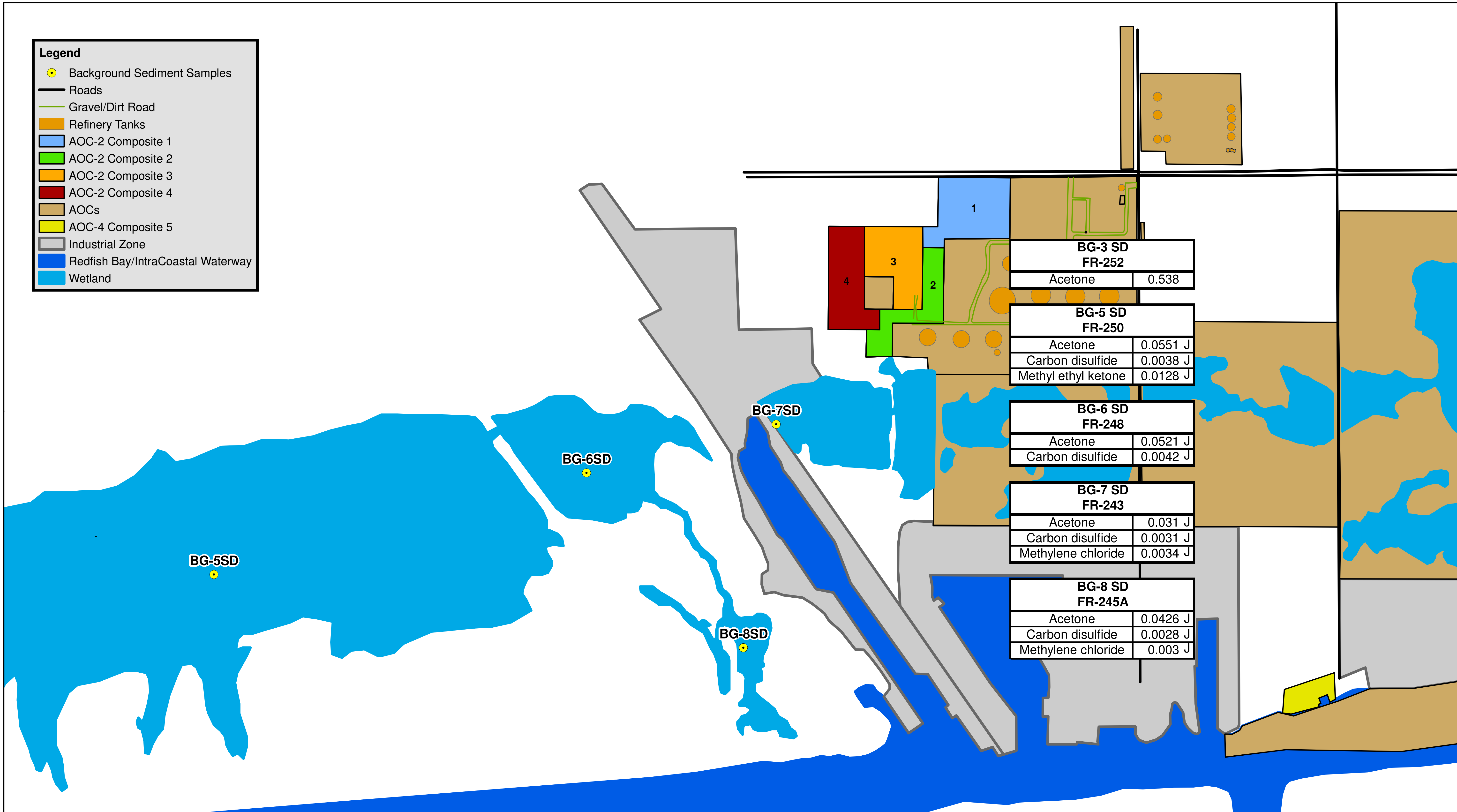
FIGURE
46A



Notes:

1. Results are posted in mg/kg

2. Qualifiers:

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

N

0 400 800

Feet

DATE DRAWN: 4/1/09	DATE REVISED:	**Background Ecological VOC Sediment Distribution Map**	FIGURE
DRAFTED BY:	C. SEATON	FALCON REFINERY INGLESIDE, SAN PATRICIO COUNTY, TEXAS	**46B**
CHECKED BY:	S. HALASZ		
APPROVED BY:		PROJ NO. 59752 / FILE NAME: Falcon Refinery Base Map	

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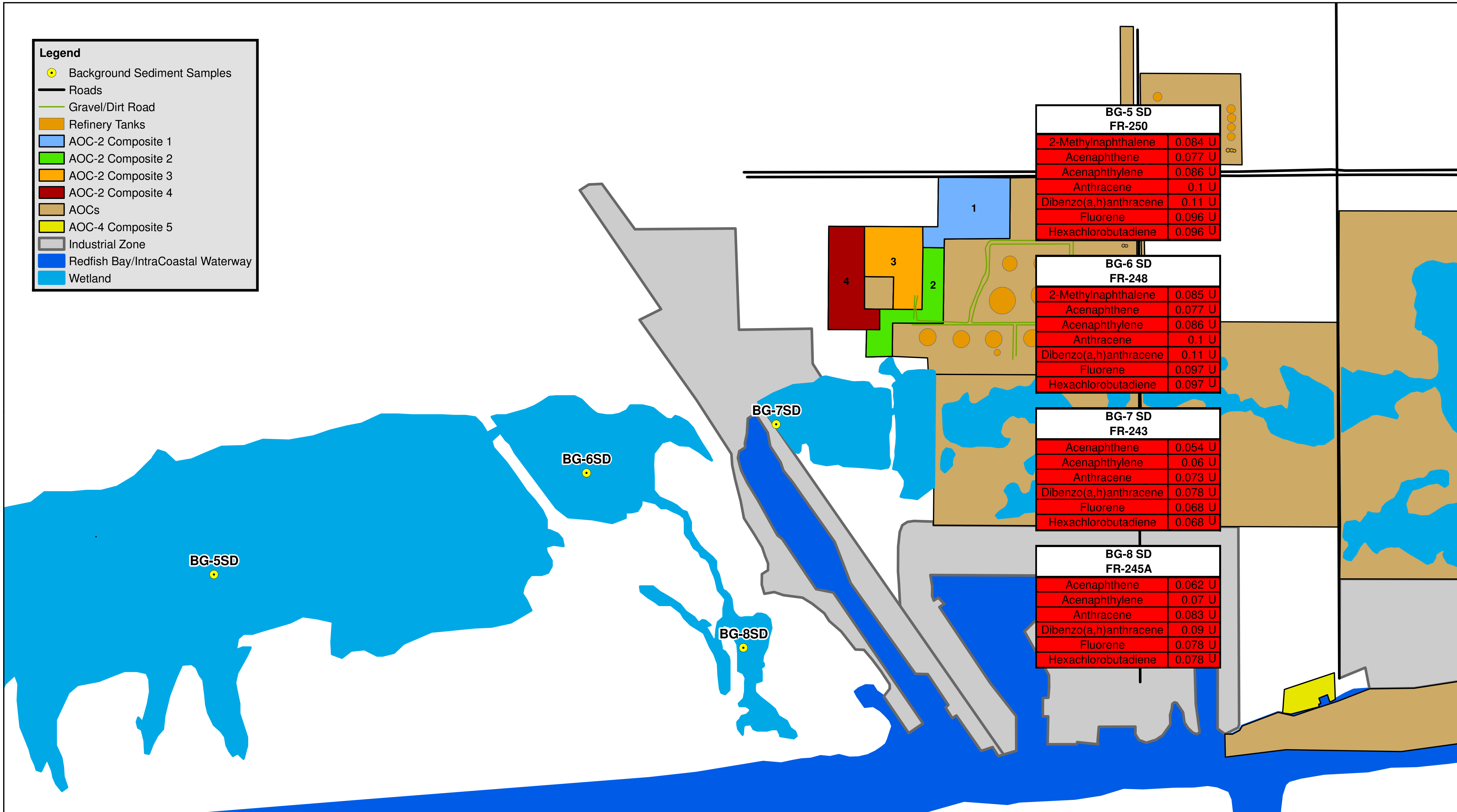

Notes:

1. Results are posted in mg/kg

2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

Exceeds Sediment Marine Screening Level

N

0 400 800

Feet

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CHECKED BY:	S. HALASZ
APPROVED BY:	

Background Ecological SVOC Sediment Distribution Map

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INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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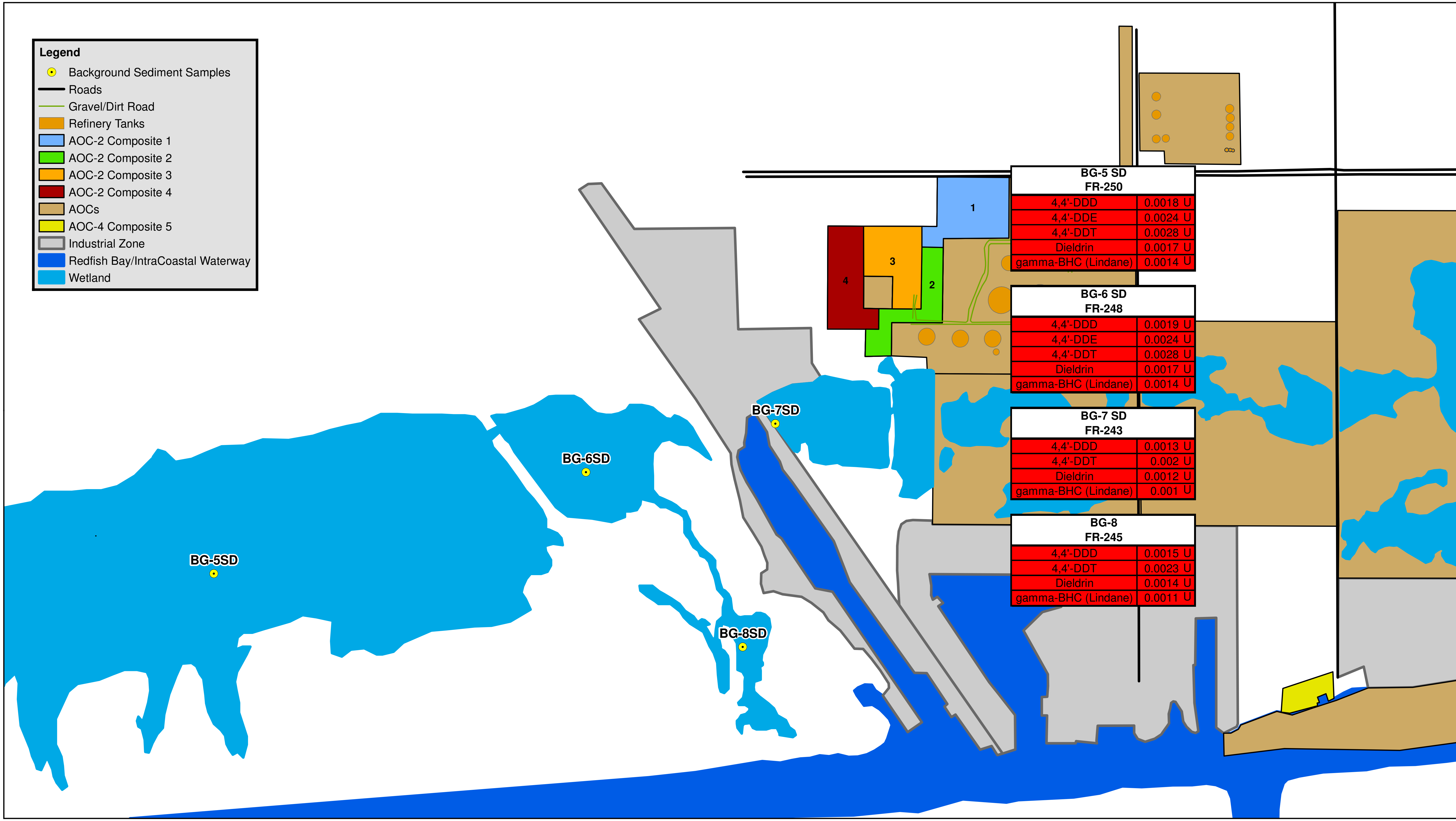
FIGURE

46C



Notes:

1. Results are posted in mg/kg

2. Qualifiers:

J = Concentration greater than the SDL but less than the method quantitation limit (MQL)

N

0 400 800

Feet

DATE DRAWN: 4/1/09	DATE REVISED:
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

Background Ecological Pesticide Sediment Distribution Map

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INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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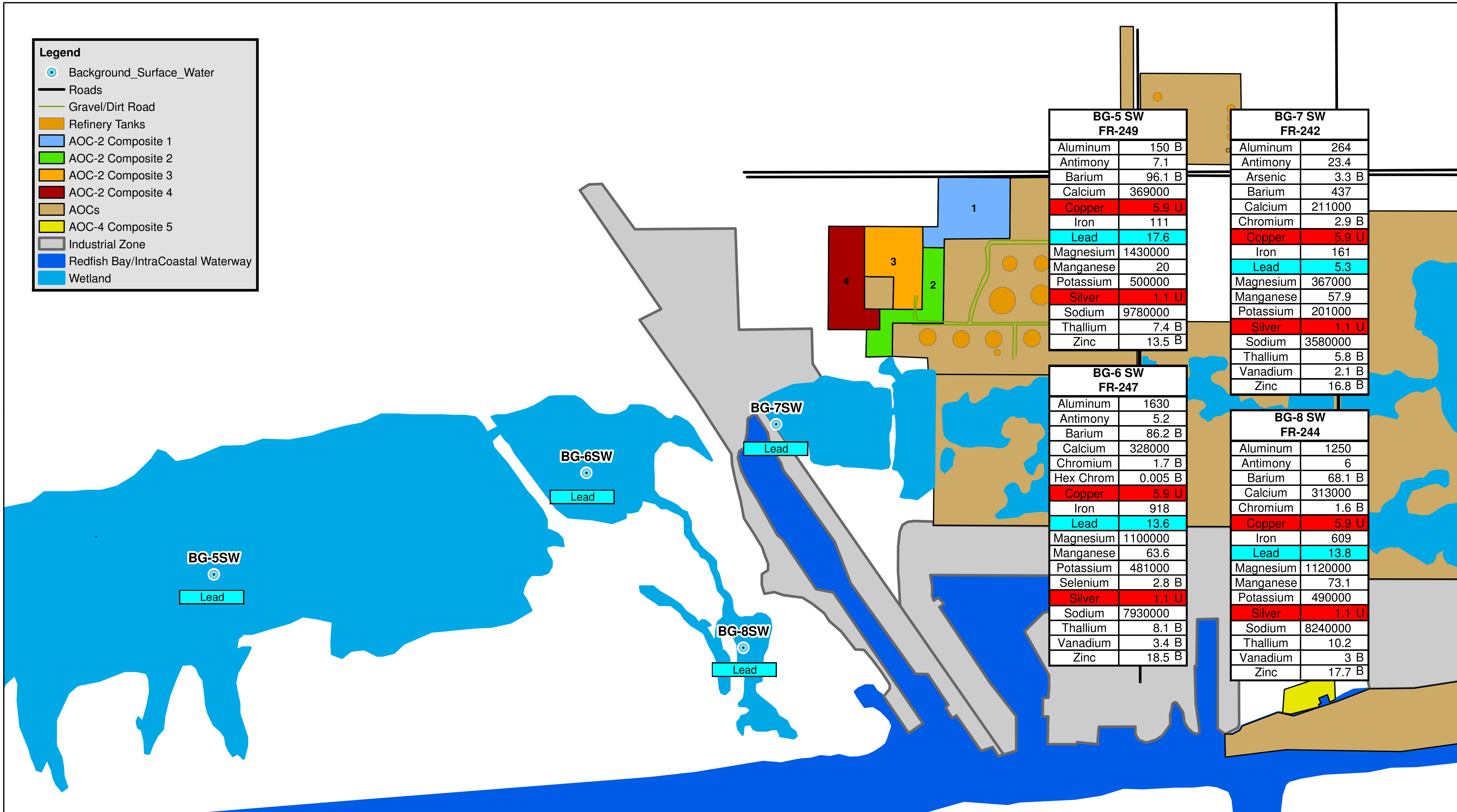
FIGURE
46D



BG-5 SW FR-249	
Aluminum	150 B
Antimony	7.1
Barium	96.1 B
Calcium	369000
Copper	5.9 U
Iron	111
Lead	17.6
Magnesium	1430000
Manganese	20
Potassium	500000
Silver	1.1 U
Sodium	9780000
Thallium	7.4 B
Zinc	13.5 B

BG-7 SW FR-242	
Aluminum	264
Antimony	23.4
Arsenic	3.3 B
Barium	437
Calcium	211000
Chromium	2.9 B
Copper	5.9 U
Iron	161
Lead	5.3
Magnesium	367000
Manganese	57.9
Potassium	201000
Silver	1.1 U
Sodium	3580000
Thallium	5.8 B
Vanadium	2.1 B
Zinc	16.8 B

BG-6 SW FR-247	
Aluminum	1630
Antimony	5.2
Barium	86.2 B
Calcium	328000
Chromium	1.7 B
Hex Chrom	0.005 B
Copper	5.9 U
Iron	918
Lead	13.6
Magnesium	1100000
Manganese	63.6
Potassium	481000
Selenium	2.8 B
Silver	1.1 U
Sodium	7930000
Thallium	8.1 B
Vanadium	3.4 B
Zinc	18.5 B

BG-8 SW FR-244	
Aluminum	1250
Antimony	6
Barium	68.1 B
Calcium	313000
Chromium	1.6 B
Copper	5.9 U
Iron	609
Lead	13.8
Magnesium	1120000
Manganese	73.1
Potassium	490000
Silver	1.1 U
Sodium	8240000
Thallium	10.2
Vanadium	3 B
Zinc	17.7 B

Notes:

1. Results are posted in µg/l
2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

B = Concentration greater than the sample detection limit (SDL) but less than the method quantitation limit (MQL)

Above Marine Limit

Exceeds Marine Screening Level

N

0 350 700

Feet

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Background Ecological Metal Surface Water Distribution Map

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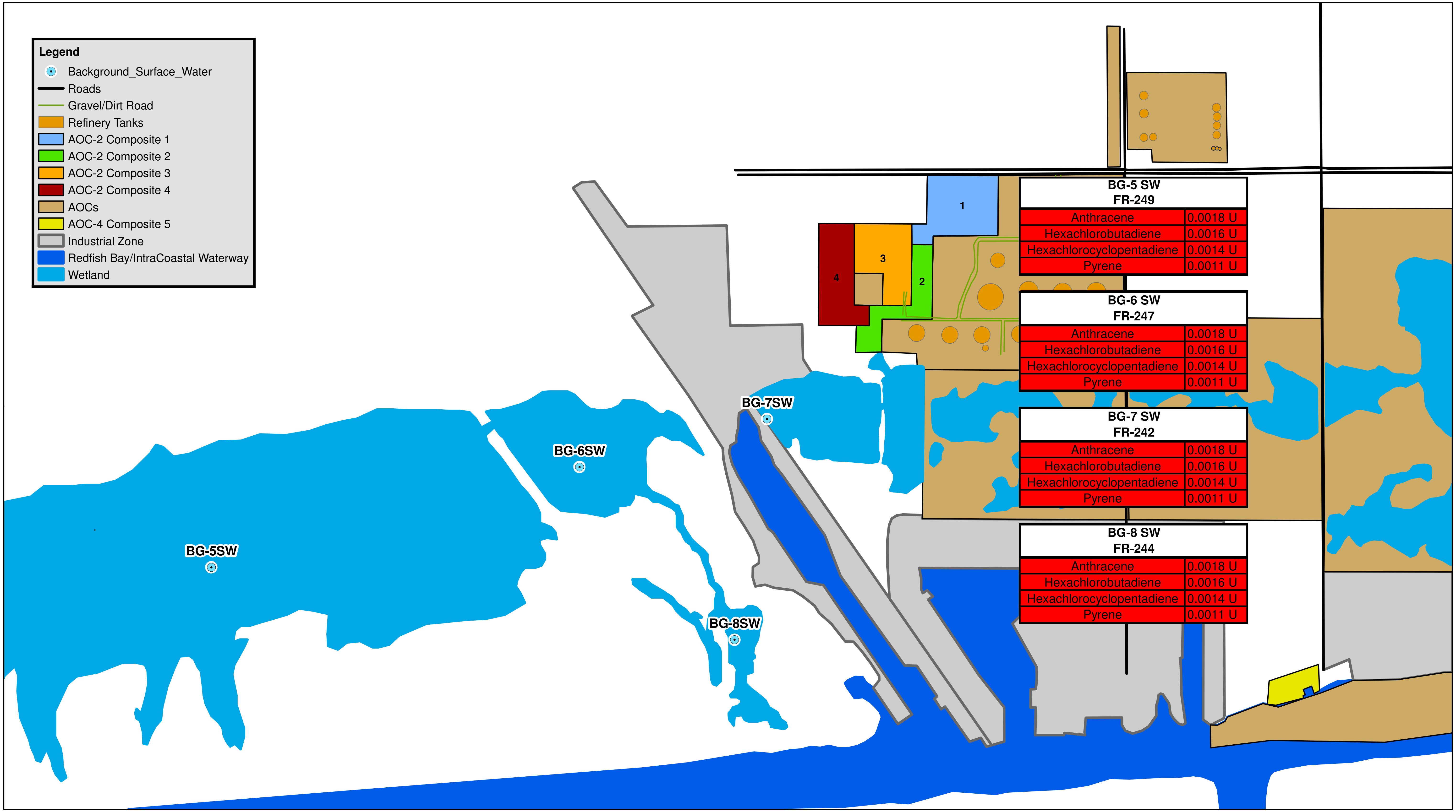
FIGURE
47A



Notes:

1. Results are posted in mg/l

2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

Exceeds Marine Screening Level

N

0 400 800

Feet

DATE DRAWN: 4/1/09	DATE REVISED:
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CHECKED BY:	S. HALASZ
APPROVED BY:	

Background Ecological SVOC Surface Water Distribution Map

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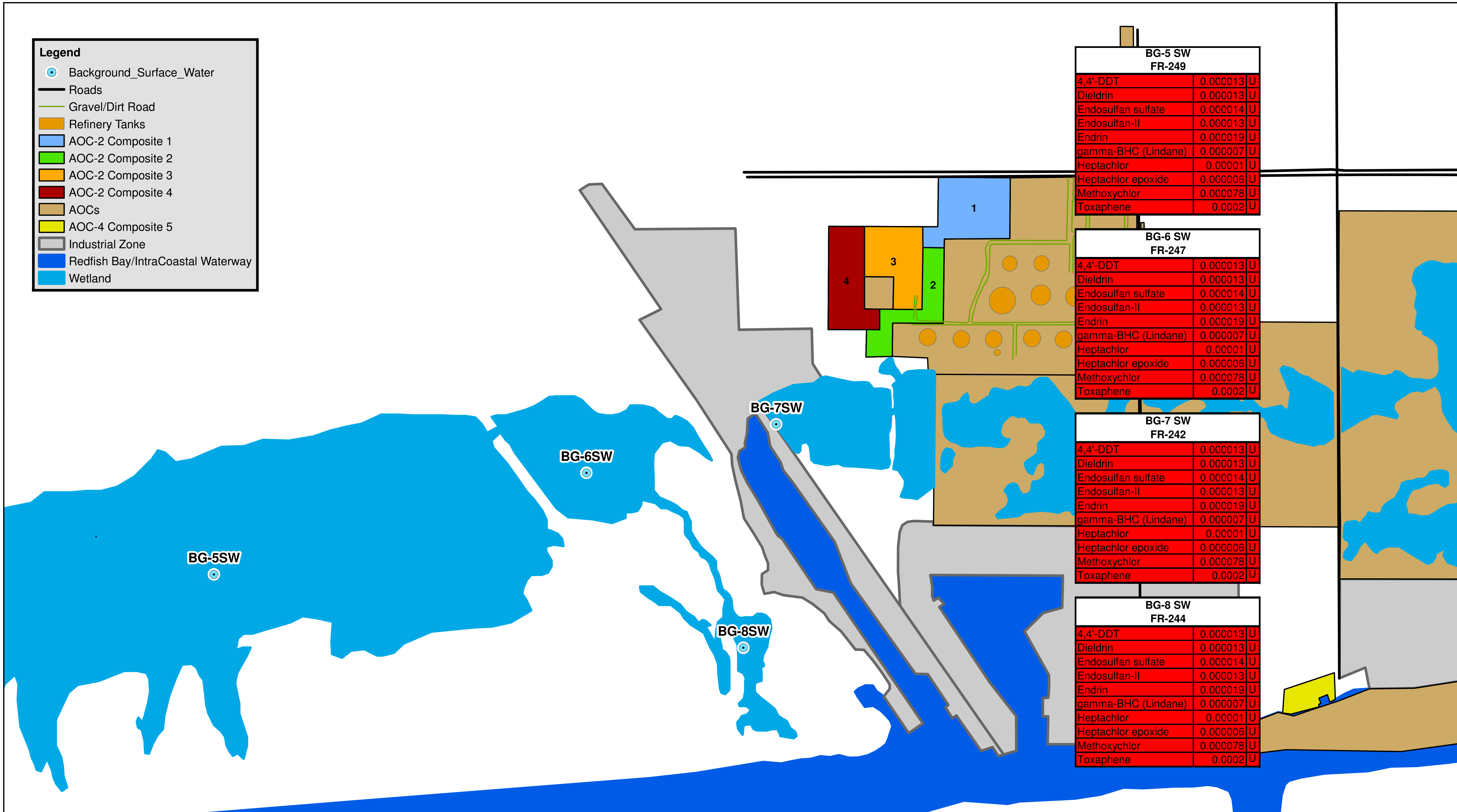
FIGURE
47B



BG-5 SW FR-249		
4,4'-DDT	0.000013	U
Dieldrin	0.000013	U
Endosulfan sulfate	0.000014	U
Endosulfan-II	0.000013	U
Endrin	0.000019	U
gamma-BHC (Lindane)	0.000007	U
Heptachlor	0.00001	U
Heptachlor epoxide	0.000006	U
Methoxychlor	0.000078	U
Toxaphene	0.0002	U

BG-6 SW FR-247		
4,4'-DDT	0.000013	U
Dieldrin	0.000013	U
Endosulfan sulfate	0.000014	U
Endosulfan-II	0.000013	U
Endrin	0.000019	U
gamma-BHC (Lindane)	0.000007	U
Heptachlor	0.00001	U
Heptachlor epoxide	0.000006	U
Methoxychlor	0.000078	U
Toxaphene	0.0002	U

BG-7 SW FR-242		
4,4'-DDT	0.000013	U
Dieldrin	0.000013	U
Endosulfan sulfate	0.000014	U
Endosulfan-II	0.000013	U
Endrin	0.000019	U
gamma-BHC (Lindane)	0.000007	U
Heptachlor	0.00001	U
Heptachlor epoxide	0.000006	U
Methoxychlor	0.000078	U
Toxaphene	0.0002	U

BG-8 SW FR-244		
4,4'-DDT	0.000013	U
Dieldrin	0.000013	U
Endosulfan sulfate	0.000014	U
Endosulfan-II	0.000013	U
Endrin	0.000019	U
gamma-BHC (Lindane)	0.000007	U
Heptachlor	0.00001	U
Heptachlor epoxide	0.000006	U
Methoxychlor	0.000078	U
Toxaphene	0.0002	U

Notes:

1. Results are posted in mg/l

2. Qualifiers:

U = Undetected at the sample detection limit (SDL)

Exceeds Marine Screening Level

N

0 400 800

Feet

DATE DRAWN: 4/1/09	DATE REVISED:
DRAFTED BY:	C. SEATON
CHECKED BY:	S. HALASZ
APPROVED BY:	

Background Ecological Pesticides Surface Water Distribution Map

FALCON REFINERY
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

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FIGURE **47C**

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APPENDIX B

PHASE 1 ANALYTICAL RESULTS FROM ACCUTEXT

See Attached Folder Titled

Appendix B
VSP REPORTS OF CALCULATED MINIMUM SAMPLE

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APPENDIX C

VSP REPORTS OF CALCULATED MINIMUM SAMPLE

APPENDIX C
INDEX OF VSP REPORTS
FALCON REFINERY
INGLESIDE, TEXAS

Report Number	Area Of Concern	Media	Benchmark	Delta Method
1	AOC-1	Surface Soil	Human Health	1
2	AOC-1	Surface Soil	Human Health	2
3	AOC-1	Surface Soil	Ecological	1
4	AOC-1	Surface Soil	Ecological	2
5	AOC-1	Subsurface Soil	Human Health	1
6	AOC-1	Subsurface Soil	Human Health	2
7	AOC-1	Subsurface Soil	Ecological	1
8	AOC-1	Subsurface Soil	Ecological	2
9	AOC-1	Groundwater	Human Health	1
10	AOC-1	Groundwater	Human Health	2
11	AOC-3	Surface Soil	Human Health	1
12	AOC-3	Surface Soil	Human Health	2
13	AOC-3	Surface Soil	Ecological	1
14	AOC-3	Surface Soil	Ecological	2
15	AOC-3	Subsurface Soil	Human Health	1
16	AOC-3	Subsurface Soil	Human Health	2
17	AOC-3	Subsurface Soil	Ecological	1
18	AOC-3	Subsurface Soil	Ecological	2
19	AOC-3	Surface Water	Human Health	1
20	AOC-3	Surface Water	Human Health	2
21	AOC-3	Surface Water	Ecological	1
22	AOC-3	Surface Water	Ecological	2
23	AOC-3	Sediment	Human Health	1
24	AOC-3	Sediment	Human Health	2
25	AOC-3	Sediment	Ecological	1
26	AOC-3	Sediment	Ecological	2

Appendix C

VSP Reports of Calculated Minimum Sample Quantity
Report 1

Area of Concern – 1

Minimum Sample Quantity Calculation for Surface Soil using Human Health Benchmarks and Delta Method 1

Random sampling locations for comparing a mean with a fixed threshold (parametric)

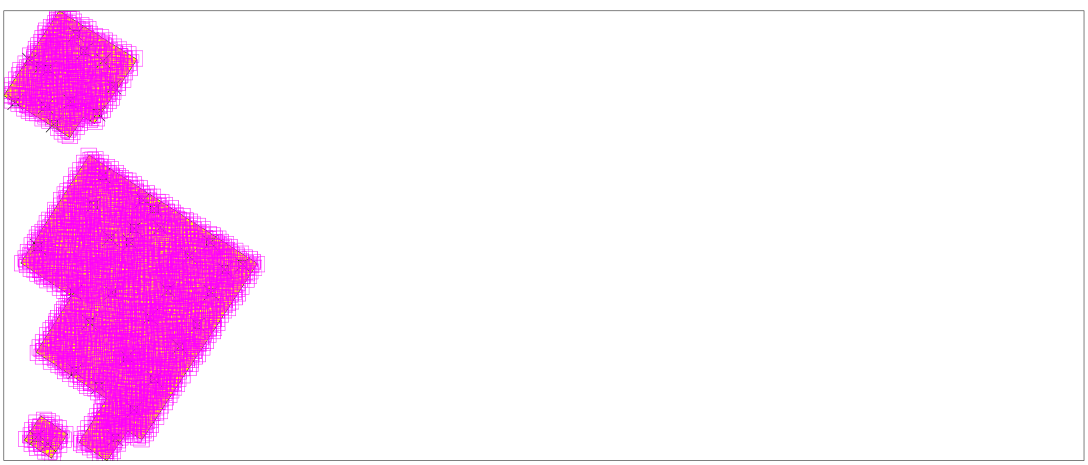
Summary

This report summarizes the sampling design, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design for Benzo(b)fluoranthene, the driving analyte (the analyte which required the largest number of samples). A figure that shows sampling locations in the field is also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean to a fixed threshold
Type of Sampling Design	Parametric
Sample Placement (Location) in the Field	Simple random sampling
Working (Null) Hypothesis	The mean value at the site exceeds the threshold
Formula for calculating number of sampling locations	Student's t-test
Calculated total number of samples	2088
Number of samples on map [a]	2088
Number of selected sample areas [b]	1
Specified sampling area [c]	188054.34 m^2
Total cost of sampling [d]	$1,045,000.00

[a] This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[d] Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.



Primary Sampling Objective

The primary purpose of sampling at this site is to compare a mean value of a site with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the mean value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the mean value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative hypothesis, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach
A parametric random sampling approach was used to determine the number of samples and to specify sampling locations. A parametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that parametric assumptions are reasonable. These assumptions will be examined in post-sampling data analysis.

Both parametric and non-parametric approaches rely on assumptions about the population. However, non-parametric approaches typically require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than the number of samples required by non-parametric approaches.

Locating the sample points randomly provides data that are separated by many distances, whereas systematic samples are all equidistant apart. Therefore, random sampling provides more information about the spatial structure of the potential contamination than systematic sampling does. As with systematic sampling, random sampling also provides information regarding the mean value, but there is the possibility that areas of the site will not be represented with the same frequency as if uniform grid sampling were performed.

Number of Total Samples: Calculation Equation and Inputs
The equation used to calculate the number of samples is based on a Student's t-test. For this site, the null hypothesis is rejected in favor of the alternative hypothesis if the sample mean is sufficiently smaller than the threshold. The number of samples to collect is calculated so that 1) there will be a high probability (1-β) of rejecting the null hypothesis if the alternative hypothesis is true and 2) a low probability (α) of rejecting the null hypothesis if the null hypothesis is true.

The formula used to calculate the number of samples is:

$$n = \frac{S^2}{\Delta^2}\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2 + 0.5Z_{1-\alpha}^2$$

where
n is the number of samples,
S is the estimated standard deviation of the measured values including analytical error,
Δ is the width of the gray region,
α is the acceptable probability of incorrectly concluding the site mean is less than the threshold,
β is the acceptable probability of incorrectly concluding the site mean exceeds the threshold,
$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is 1-α,
$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is 1-β.

The values of these inputs that result in the calculated number of sampling locations are:

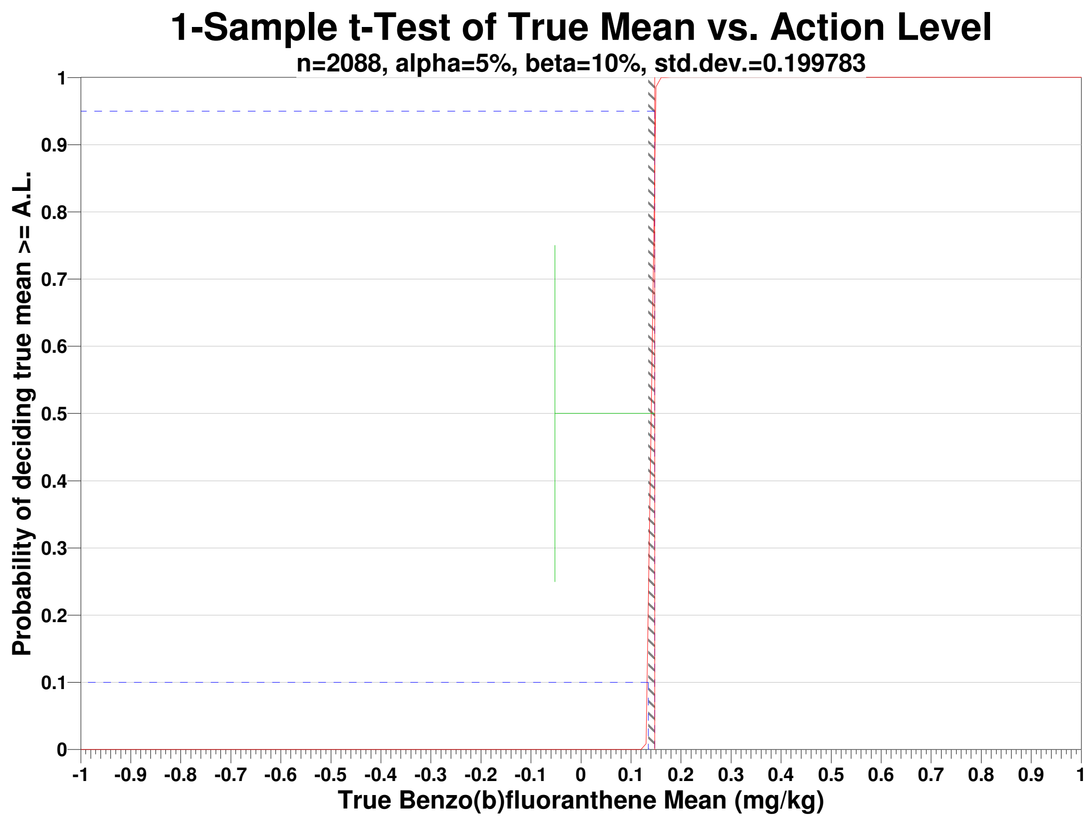
Analyte	n	Parameter					
		S	**Δ**	**α**	**β**	***$Z_{1-\alpha}$*** [a]	***$Z_{1-\beta}$*** [b]
New Location	2	0.1 mg/kg	10 mg/kg	0.05	0.1	1.64485	1.28155
1_2_4-Trimethylbenzene	2	0.00059013 mg/kg	52.1441 mg/kg	0.05	0.1	1.64485	1.28155
Acetone	2	0.0152671 mg/kg	5417.4 mg/kg	0.05	0.1	1.64485	1.28155
Aluminum	365	5176.14 mg/kg	795.182 mg/kg	0.05	0.1	1.64485	1.28155
Arsenic	11	0.899292 mg/kg	0.856182 mg/kg	0.05	0.1	1.64485	1.28155
Barium	2	234.679 mg/kg	7712.13 mg/kg	0.05	0.1	1.64485	1.28155
Benzo(a)anthracene	429	0.685504 mg/kg	0.0970276 mg/kg	0.05	0.1	1.64485	1.28155
Benzo(a)pyrene	31	0.179864 mg/kg	0.0969211 mg/kg	0.05	0.1	1.64485	1.28155
Benzo(b)fluoranthene	2088	0.199783 mg/kg	0.0128017 mg/kg	0.05	0.1	1.64485	1.28155
Beryllium	2	0.180444 mg/kg	37.3664 mg/kg	0.05	0.1	1.64485	1.28155

bis(2-Ethylhexyl)phthalate	2	0.170899 mg/kg	34.5985 mg/kg	0.05	0.1	1.64485	1.28155
Cadmium	2	0.181351 mg/kg	38.879 mg/kg	0.05	0.1	1.64485	1.28155
Chromium	2	3.52689 mg/kg	205.698 mg/kg	0.05	0.1	1.64485	1.28155
Chromium_ Hexavalent	2	0.499077 mg/kg	29.2971 mg/kg	0.05	0.1	1.64485	1.28155
Chrysene	4	6.5541 mg/kg	13.4296 mg/kg	0.05	0.1	1.64485	1.28155
Cobalt	2	0.998894 mg/kg	901.602 mg/kg	0.05	0.1	1.64485	1.28155
Copper	2	4.00774 mg/kg	543.485 mg/kg	0.05	0.1	1.64485	1.28155
Isopropylbenzene	2	0.00356517 mg/kg	370.837 mg/kg	0.05	0.1	1.64485	1.28155
Lead	2	17.8896 mg/kg	385.691 mg/kg	0.05	0.1	1.64485	1.28155
Manganese	2	55.7772 mg/kg	3160.79 mg/kg	0.05	0.1	1.64485	1.28155
Mercury	2	0.114336 mg/kg	2.05571 mg/kg	0.05	0.1	1.64485	1.28155
Methylene chloride	2	0.00491894 mg/kg	1.25683 mg/kg	0.05	0.1	1.64485	1.28155
Nickel	2	2.08703 mg/kg	829.565 mg/kg	0.05	0.1	1.64485	1.28155
Phenanthrene	2	0.340649 mg/kg	1705.05 mg/kg	0.05	0.1	1.64485	1.28155
Pyrene	2	0.280759 mg/kg	1697.44 mg/kg	0.05	0.1	1.64485	1.28155
Toluene	2	0.000748414 mg/kg	521.169 mg/kg	0.05	0.1	1.64485	1.28155
Vanadium	2	6.37936 mg/kg	283.379 mg/kg	0.05	0.1	1.64485	1.28155
Xylene (total)	2	0.00135816 mg/kg	214.477 mg/kg	0.05	0.1	1.64485	1.28155
Zinc	2	46.5764 mg/kg	9874.84 mg/kg	0.05	0.1	1.64485	1.28155

[a] This value is automatically calculated by VSP based upon the user defined value of α.
[b] This value is automatically calculated by VSP based upon the user defined value of β.

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000) for Benzo(b)fluoranthene, the driving analyte. It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true mean values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at 1-α on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at 1-α. If any of the inputs change, the number of samples that result in the correct curve changes.



Statistical Assumptions

The assumptions associated with the formulas for computing the number of samples are:

1. the sample mean is normally distributed (this happens if the data are roughly symmetric or the sample size is more than 30; for extremely skewed data sets, additional samples may be required for the sample mean to be normally distributed),
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected randomly.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the sample locations were selected using a random process.

Sensitivity Analysis

The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that μ > action level and alpha (%), probability of mistakenly concluding that μ < action level. The following table shows the results of this analysis.

Number of Samples							
AL=0.1476		α=5		α=10		α=15	
		s=0.399566	s=0.199783	s=0.399566	s=0.199783	s=0.399566	s=0.199783
LBGR=90	β=5	7933	1985	6277	1570	5270	1318
	β=10	6278	1571	4816	1205	3939	985
	β=15	5270	1319	3939	986	3150	788
LBGR=80	β=5	1985	498	1570	394	1318	330
	β=10	1571	394	1205	302	985	247
	β=15	1319	331	986	247	788	198
LBGR=70	β=5	883	222	699	176	586	147

	β=10	699	176	536	135	439	110
	β=15	587	148	439	111	351	89

s = Standard Deviation
LBGR = Lower Bound of Gray Region (% of Action Level)
β = Beta (%), Probability of mistakenly concluding that μ > action level
α = Alpha (%), Probability of mistakenly concluding that μ < action level
AL = Action Level (Threshold)

Cost of Sampling
The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that are based on the number of samples collected and measured. Based on the numbers of samples determined above, the estimated total cost of sampling and analysis at this site is $1,045,000.00, which averages out to a per sample cost of $500.48. The following table summarizes the inputs and resulting cost estimates.

COST INFORMATION			
Cost Details	**Per Analysis**	**Per Sample**	**2088 Samples**
Field collection costs		$100.00	$208,800.00
Analytical costs	$400.00	$400.00	$835,200.00
Sum of Field & Analytical costs		**$500.00**	**$1,044,000.00**
Fixed planning and validation costs			$1,000.00
Total cost			**$1,045,000.00**

Data Analysis for New Location

SUMMARY STATISTICS for New Location	
n	5047
Min	0
Max	0
Range	0
Mean	0
Median	0
Variance	0
StdDev	0
Std Error	0
Skewness	-1.#IND
Interquartile Range	0

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0	0	0	0	0	0	0	0	0

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any

values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for New Location			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	-1.#IO	4.411	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Lilliefors test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Lilliefors Test Statistic	0
Lilliefors 5% Critical Value	0.01247

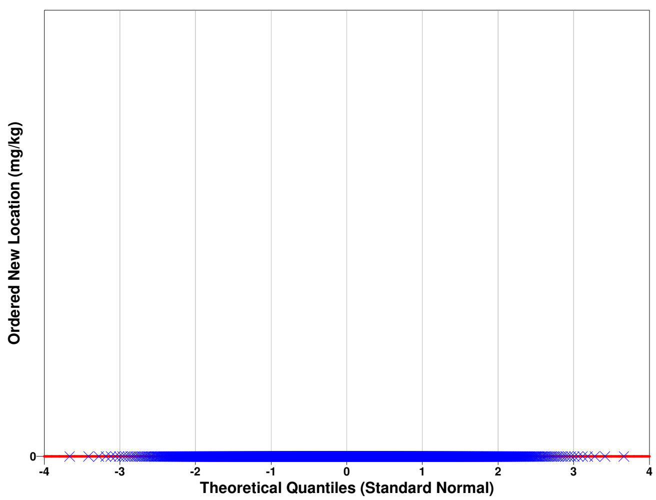
The calculated Lilliefors test statistic is less than the 5% Lilliefors critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do appear to follow a normal distribution at the 5% level of significance.

Data Plots for New Location
Graphical displays of the data are shown below.

The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.



For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for New Location

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Lilliefors test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Lilliefors Test Statistic	0
Lilliefors 5% Critical Value	0.01247

The calculated Lilliefors test statistic is less than the 5% Lilliefors critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0

95% Non-Parametric (Chebyshev) UCL	0

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=5047 data,
AL is the action level or threshold (0.1476),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=5046 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.#IND	1.6452	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Data Analysis for 1_2_4-Trimethylbenzene
The following data points were entered by the user for analysis.

1_2_4-Trimethylbenzene (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0006	0.0006	0.0006	0.0006	0.0006	0.00065	0.00065	0.00065	0.00065	0.00065
10	0.00065	0.00065	0.00065	0.00065	0.00065	0.00065	0.00065	0.000675	0.0007	0.0007
20	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.00075
30	0.00075	0.0008	0.00095	0.0015	0.0015	0.0015	0.0019	0.00195	0.002	0.0025
40	0.0032									

SUMMARY STATISTICS for 1_2_4-Trimethylbenzene	
n	41
Min	0.0006
Max	0.0032
Range	0.0026
Mean	0.00093841
Median	0.0007
Variance	3.4825e-007
StdDev	0.00059013
Std Error	9.2163e-005

Skewness				2.3483				
Interquartile Range				0.000125				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0006	0.0006	0.0006	0.00065	0.0007	0.000775	0.00194	0.00245	0.0032

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for 1_2_4-Trimethylbenzene			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.832	3.05	Yes

The test statistic 3.832 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for 1_2_4-Trimethylbenzene	
1	0.0032

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5935
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

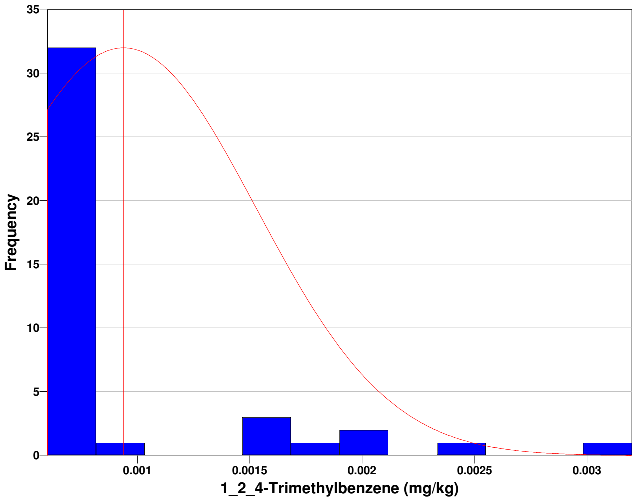
Data Plots for 1_2_4-Trimethylbenzene
Graphical displays of the data are shown below.

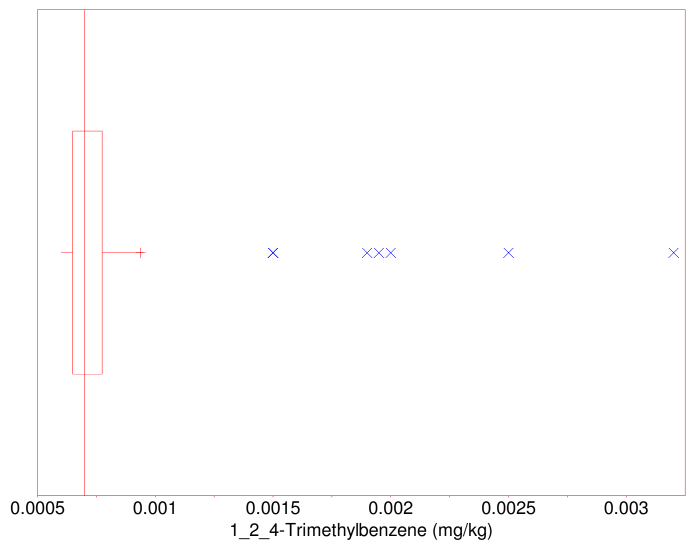
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

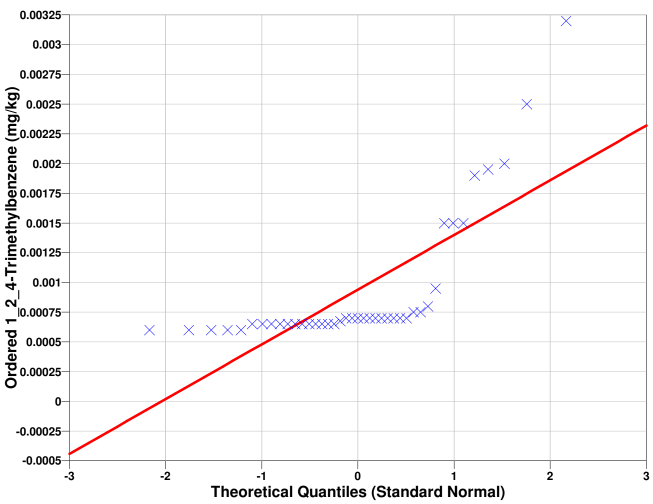
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles,

respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for 1_2_4-Trimethylbenzene
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5943

Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.001094
95% Non-Parametric (Chebyshev) UCL	0.00134

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.00134) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.1476),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-5.6578e+005	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Acetone
The following data points were entered by the user for analysis.

Acetone (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00385	0.0039	0.00395	0.00405	0.00405	0.0041	0.0041	0.0041	0.00415	0.00418

10	0.0042	0.00423	0.00425	0.00425	0.00435	0.00435	0.00438	0.00445	0.00445	0.0045
20	0.0045	0.0045	0.0045	0.0045	0.0045	0.00455	0.00455	0.00455	0.0046	0.0046
30	0.0046	0.00475	0.005	0.005	0.0065	0.0099	0.0099	0.0121	0.0125	0.0401
40	0.0963									

SUMMARY STATISTICS for Acetone								
n	41							
Min	0.00385							
Max	0.0963							
Range	0.09245							
Mean	0.0081912							
Median	0.0045							
Variance	0.00023308							
StdDev	0.015267							
Std Error	0.0023843							
Skewness	5.2787							
Interquartile Range	0.000485							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00385	0.003905	0.00405	0.00419	0.0045	0.004675	0.01166	0.03734	0.0963

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Acetone			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.771	3.05	Yes

The test statistic 5.771 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Acetone	
1	0.0963

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)

Shapiro-Wilk Test Statistic	0.3513
Shapiro-Wilk 5% Critical Value	0.94

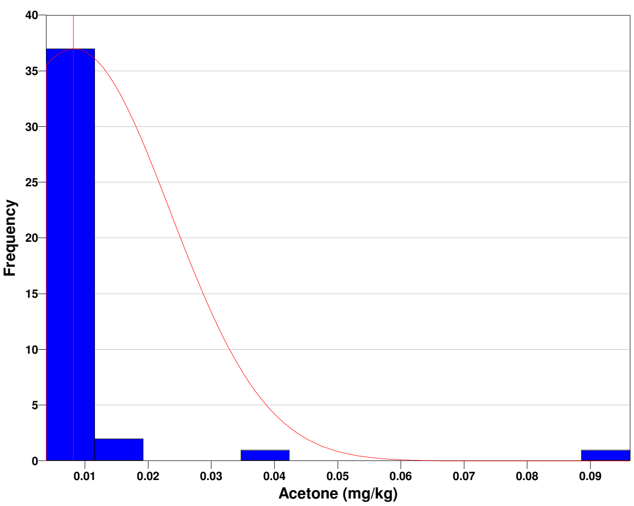
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

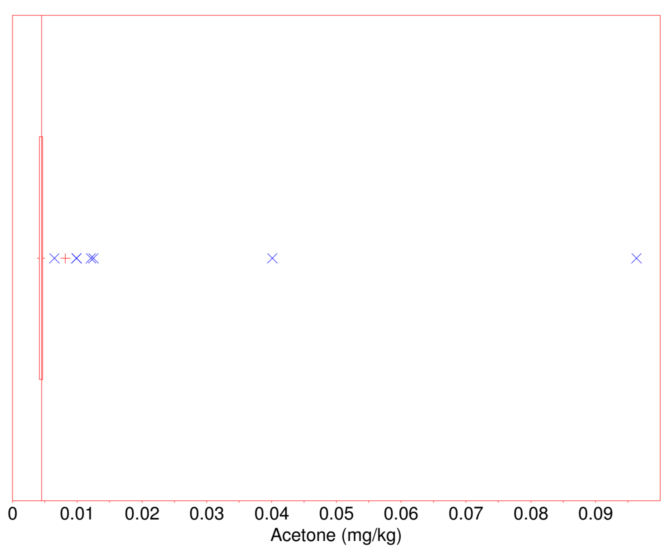
Data Plots for Acetone
Graphical displays of the data are shown below.

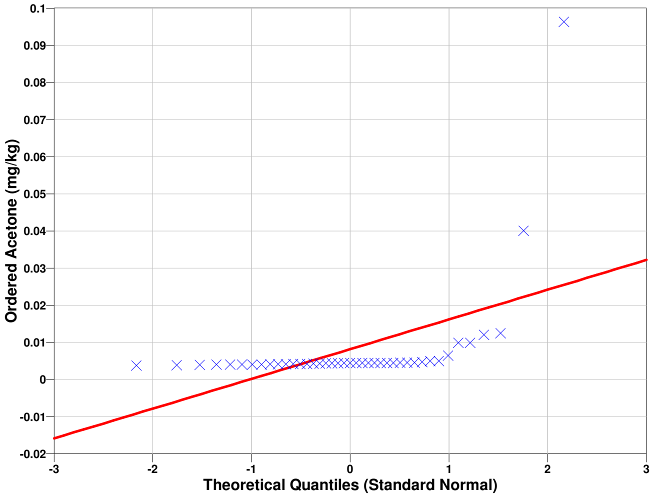
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Acetone
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.2997
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.01221
95% Non-Parametric (Chebyshev) UCL	0.01858

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.01858) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.1476),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-2.2721e+006	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Aluminum
The following data points were entered by the user for analysis.

Aluminum (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	609	640	786	820	1110	1250	1440	1670	2110	2540
10	2550	2590	2600	2710	2900	3010	3030	3550	3680	4380
20	4470	4570	4830	5020	5110	5130	5460	5510	5620	6190
30	7070	7830	8090	9850	9900	1.22e+004	1.42e+004	1.43e+004	1.44e+004	1.57e+004
40	2.54e+004									

SUMMARY STATISTICS for Aluminum								
n	41							
Min	609							
Max	25400							
Range	24791							
Mean	5727.4							
Median	4470							
Variance	2.6816e+007							
StdDev	5178.4							
Std Error	808.73							
Skewness	1.8561							
Interquartile Range	4905							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
609	654.6	878	2545	4470	7450	1.428e+004	1.557e+004	2.54e+004

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Aluminum			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.799	3.05	Yes

The test statistic 3.799 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Aluminum	
1	25400

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8541
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

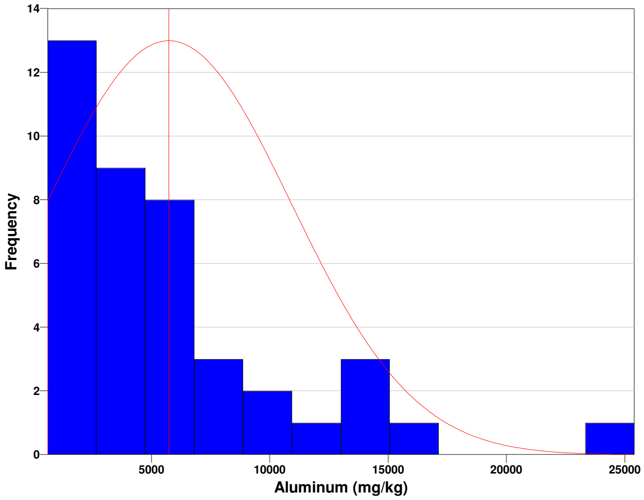
Data Plots for Aluminum
Graphical displays of the data are shown below.

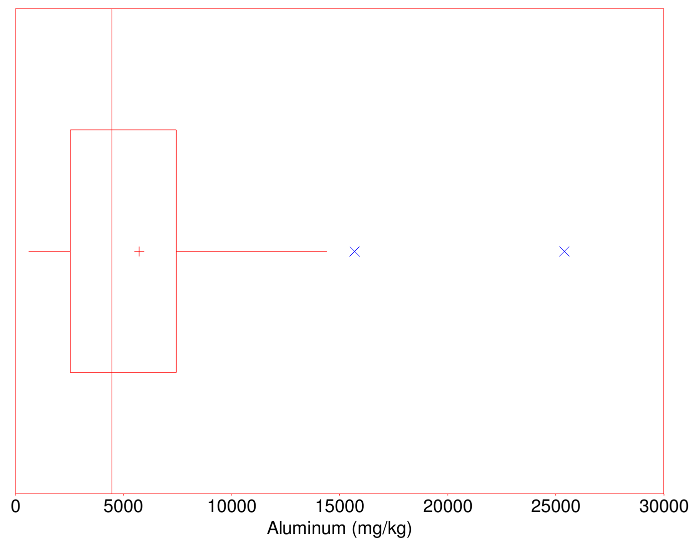
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

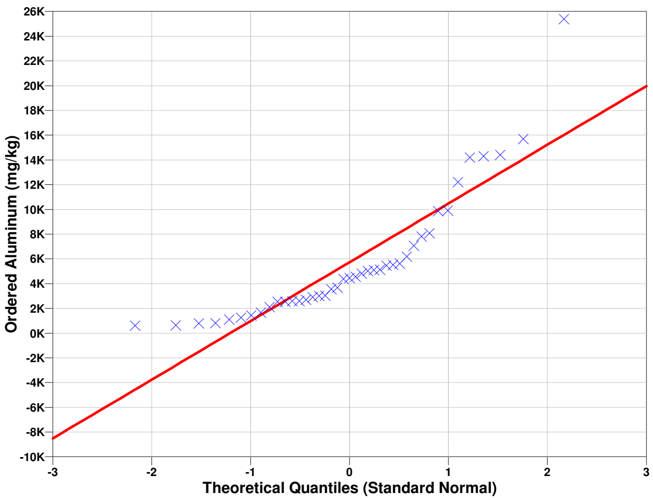
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the

Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Aluminum
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8146
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	7089
95% Non-Parametric (Chebyshev) UCL	9253

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (9253) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.1476),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-0.98144	1.6839	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
30	26	Reject

Data Analysis for Arsenic
The following data points were entered by the user for analysis.

Arsenic (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.09	0.11	0.12	0.22	0.23	0.278	0.29	0.305	0.31	0.35
10	0.51	0.53	0.57	0.58	0.66	0.72	0.83	0.86	0.93	1.04
20	1.1	1.2	1.3	1.3	1.4	1.45	1.5	1.6	1.7	1.8
30	2	2	2	2.2	2.4	2.5	2.6	2.6	2.8	3
40	3.1									

SUMMARY STATISTICS for Arsenic	
n	41

Min				0.09				
Max				3.1				
Range				3.01				
Mean				1.2459				
Median				1.1				
Variance				0.80868				
StdDev				0.89926				
Std Error				0.14044				
Skewness				0.50174				
Interquartile Range				1.57				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.09	0.111	0.222	0.43	1.1	2	2.6	2.98	3.1

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Arsenic			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.062	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.92
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

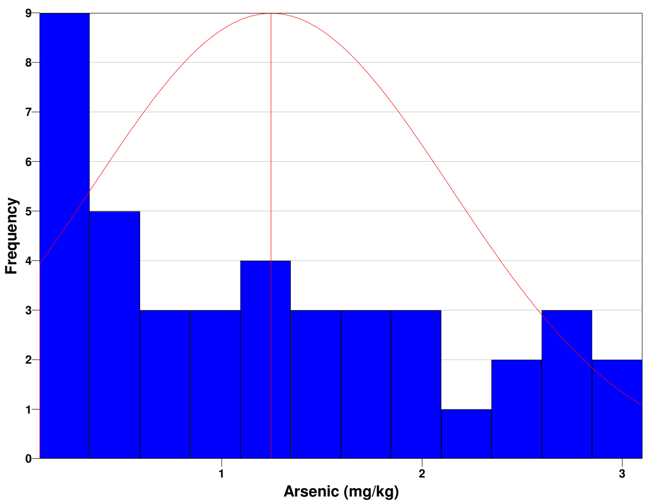
Data Plots for Arsenic
Graphical displays of the data are shown below.

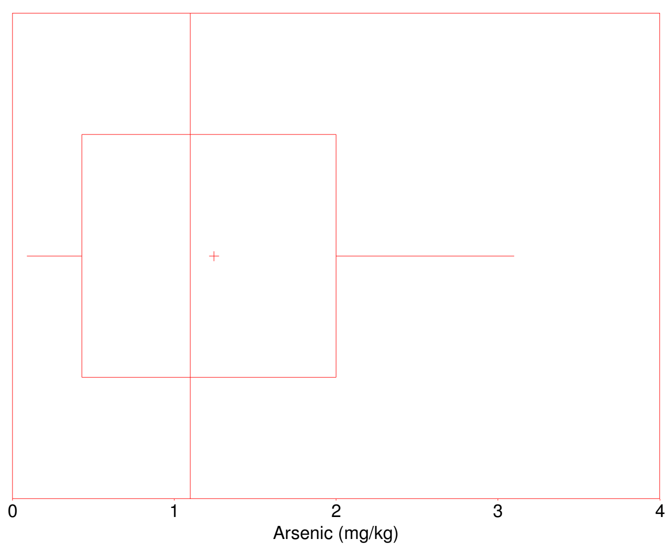
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each

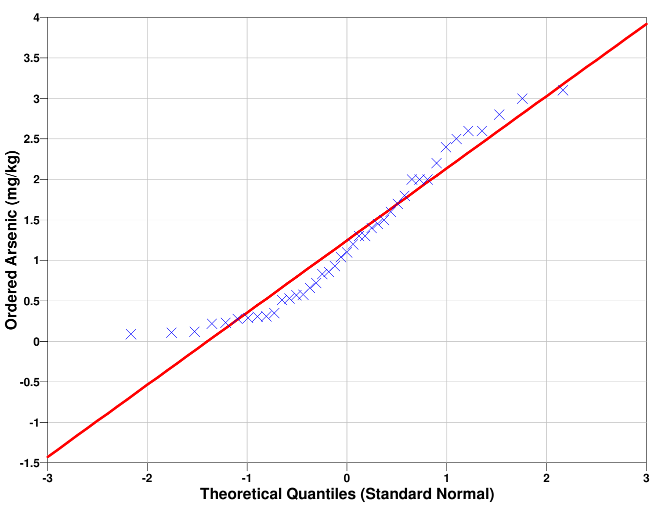
bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Arsenic
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.918
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	1.482
95% Non-Parametric (Chebyshev) UCL	1.858

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (1.858) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.1476),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
6.0972	1.6839	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
10	26	Cannot Reject
Note: There may not be enough data to reject the null hypothesis (and conclude site is clean) with 95% confidence using the MARSSIM sign test.		

Data Analysis for Barium
The following data points were entered by the user for analysis.

Barium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	6.25	13.7	13.9	19	23.4	25.9	26.9	28.4	30.2	31.4
10	36	36.1	36.7	39.9	41.4	53.5	60.3	61.5	61.7	63.5
20	64.5	66.6	67.1	69.1	72.2	86.4	88.9	91.8	94	98.6
30	103	104	109	160	162	165	177	200	381	944
40	1250									

SUMMARY STATISTICS for Barium	
n	41
Min	6.25
Max	1250
Range	1243.8
Mean	128.39
Median	64.5
Variance	55073
StdDev	234.68
Std Error	36.65
Skewness	3.968
Interquartile Range	69.8

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
6.25	13.72	19.88	33.7	64.5	103.5	195.4	887.7	1250

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Barium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.779	3.05	Yes

The test statistic 4.779 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Barium

1	1250

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.4913
Shapiro-Wilk 5% Critical Value	0.94

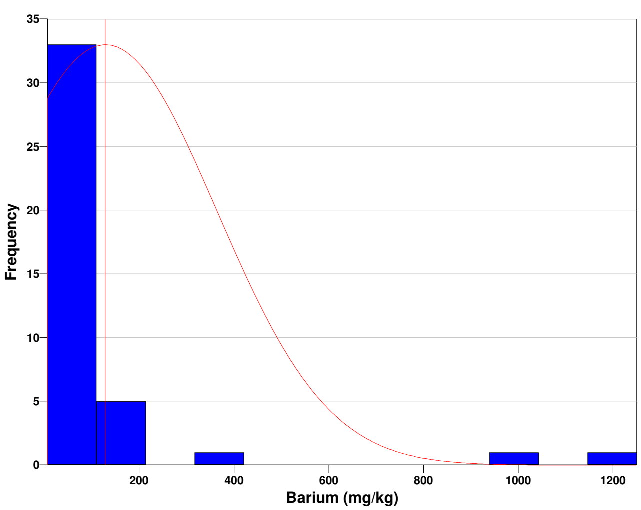
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

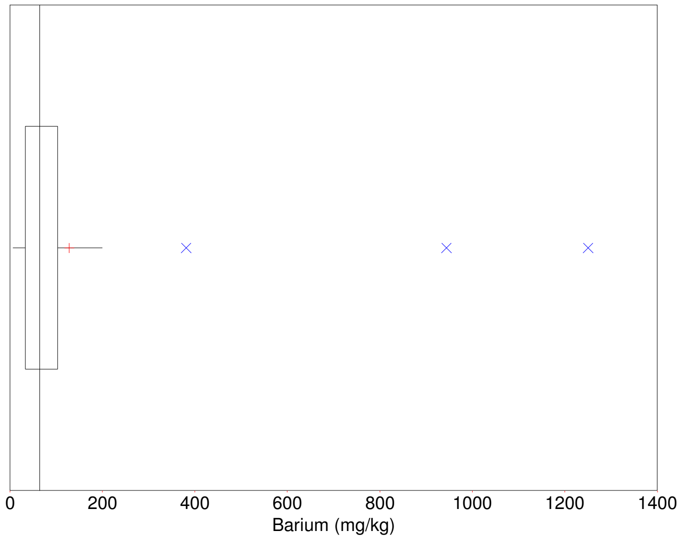
Data Plots for Barium
Graphical displays of the data are shown below.

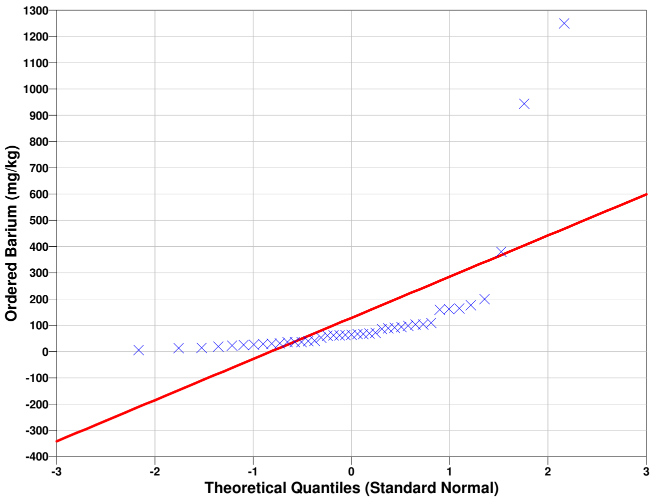
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Barium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.4558
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	190.1

95% Non-Parametric (Chebyshev) UCL	288.1

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (288.1) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.1476),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-210.42	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Benzo(a)anthracene
The following data points were entered by the user for analysis.

Benzo(a)anthracene (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.034	0.035	0.036	0.036	0.036	0.0365	0.037	0.037	0.037	0.037
10	0.0375	0.0375	0.0378	0.038	0.038	0.038	0.0385	0.0388	0.039	0.039
20	0.0395	0.04	0.04	0.04	0.0405	0.041	0.041	0.042	0.042	0.0425
30	0.055	0.121	0.142	0.355	0.36	0.37	0.39	0.398	0.648	0.72
40	3.97									

SUMMARY STATISTICS for Benzo(a)anthracene	
n	41
Min	0.034
Max	3.97

Range				3.936				
Mean				0.21173				
Median				0.0395				
Variance				0.39116				
StdDev				0.62543				
Std Error				0.097675				
Skewness				5.711				
Interquartile Range				0.05075				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.034	0.0351	0.036	0.03725	0.0395	0.088	0.3964	0.7128	3.97

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Benzo(a)anthracene			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	6.009	3.05	Yes

The test statistic 6.009 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Benzo(a)anthracene	
1	3.97

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5398
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

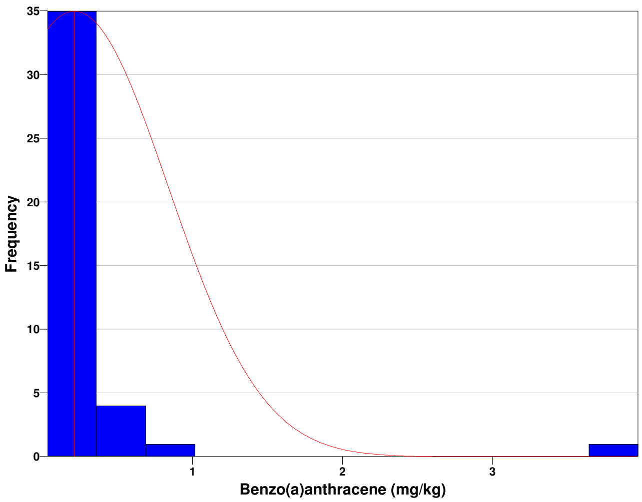
Data Plots for Benzo(a)anthracene
Graphical displays of the data are shown below.

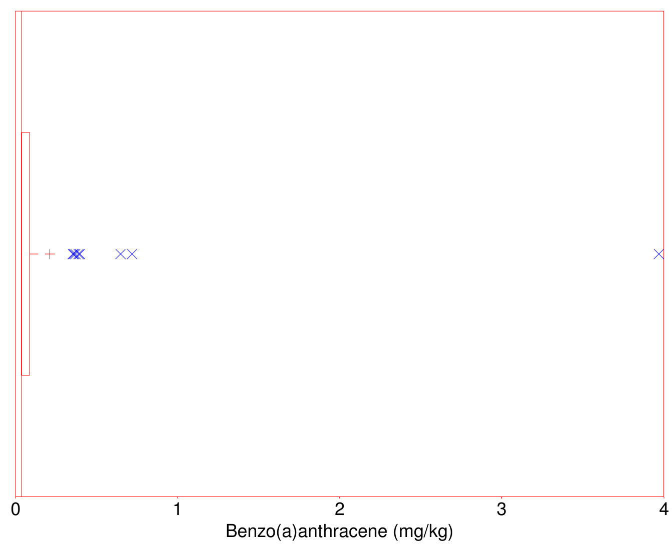
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

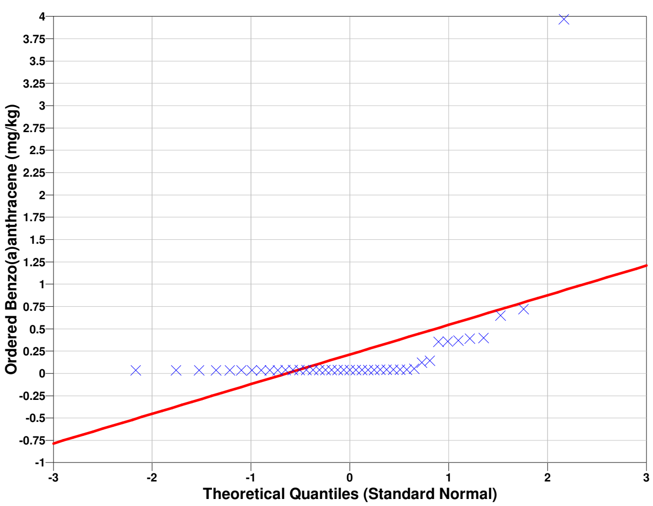
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Benzo(a)anthracene
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.3091
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.3762
95% Non-Parametric (Chebyshev) UCL	0.6375

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.6375) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.1476),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
0.65641	1.6839	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
33	26	Reject

Data Analysis for Benzo(a)pyrene
The following data points were entered by the user for analysis.

Benzo(a)pyrene (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.03	0.031	0.0315	0.0315	0.0315	0.032	0.0325	0.0325	0.0325	0.0328
10	0.0328	0.033	0.033	0.0333	0.0335	0.0335	0.0335	0.0338	0.034	0.0345
20	0.035	0.035	0.035	0.035	0.0355	0.036	0.036	0.037	0.037	0.0375
30	0.0485	0.07	0.0985	0.172	0.31	0.315	0.325	0.34	0.348	0.766
40	0.775									

SUMMARY STATISTICS for Benzo(a)pyrene	
n	41
Min	0.03
Max	0.775
Range	0.745
Mean	0.1117
Median	0.035
Variance	0.032356
StdDev	0.17988
Std Error	0.028092
Skewness	2.7482
Interquartile Range	0.02645

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.03	0.03105	0.0315	0.0328	0.035	0.05925	0.337	0.7242	0.775

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Benzo(a)pyrene			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.688	3.05	Yes

The test statistic 3.688 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Benzo(a)pyrene

1	0.775

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5037
Shapiro-Wilk 5% Critical Value	0.94

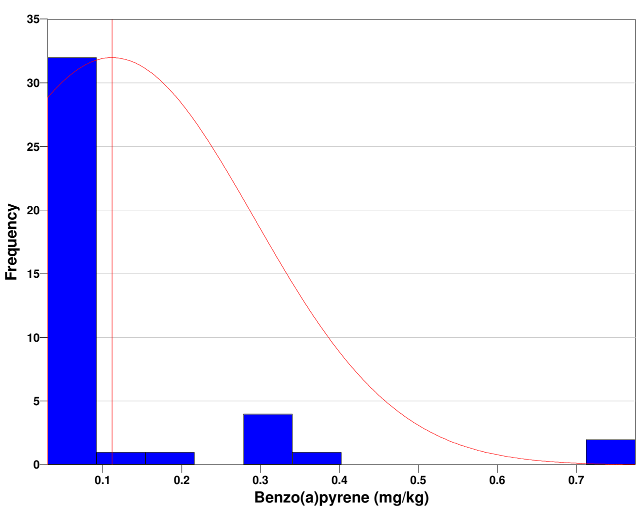
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

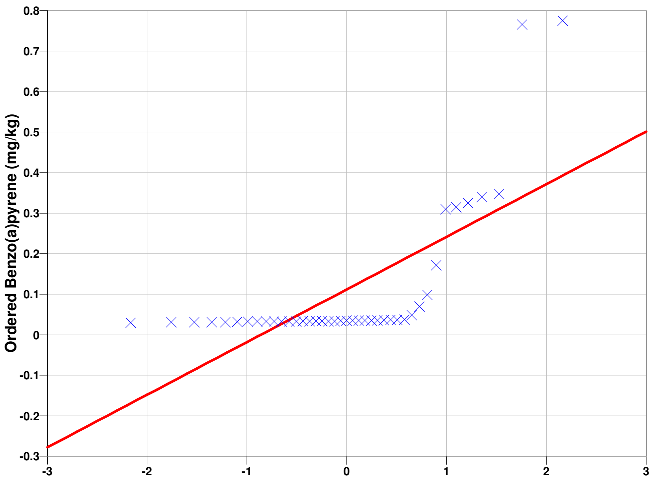
Data Plots for Benzo(a)pyrene
Graphical displays of the data are shown below.

The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.





For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Benzo(a)pyrene
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5102
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.159

95% Non-Parametric (Chebyshev) UCL	0.2342

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.2342) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.1476),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
3.4507	1.6839	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
0	26	Cannot Reject
Note: There may not be enough data to reject the null hypothesis (and conclude site is clean) with 95% confidence using the MARSSIM sign test.		

Data Analysis for Benzo(b)fluoranthene
The following data points were entered by the user for analysis.

Benzo(b)fluoranthene (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0385	0.04	0.041	0.041	0.041	0.0415	0.042	0.042	0.042	0.04225
10	0.0425	0.0425	0.04275	0.043	0.043	0.0435	0.0435	0.04375	0.044	0.0445
20	0.045	0.045	0.04525	0.0455	0.046	0.0465	0.0465	0.048	0.048	0.0485
30	0.065	0.135	0.181	0.218	0.405	0.41	0.42	0.44	0.45	0.465
40	1.03									

SUMMARY STATISTICS for Benzo(b)fluoranthene

n				41				
Min				0.0385				
Max				1.03				
Range				0.9915				
Mean				0.13482				
Median				0.045				
Variance				0.039913				
StdDev				0.19978				
Std Error				0.031201				
Skewness				2.816				
Interquartile Range				0.057625				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0385	0.0401	0.041	0.04238	0.045	0.1	0.436	0.4635	1.03

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Benzo(b)fluoranthene			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.481	3.05	Yes

The test statistic 4.481 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Benzo(b)fluoranthene	
1	1.03

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.542
Shapiro-Wilk 5% Critical Value	0.94

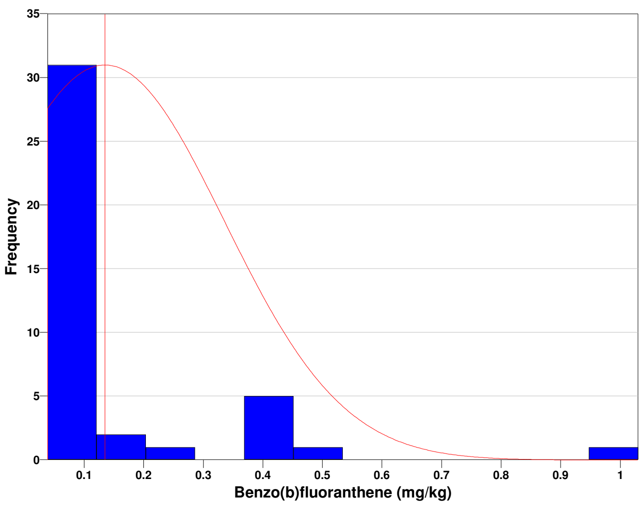
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

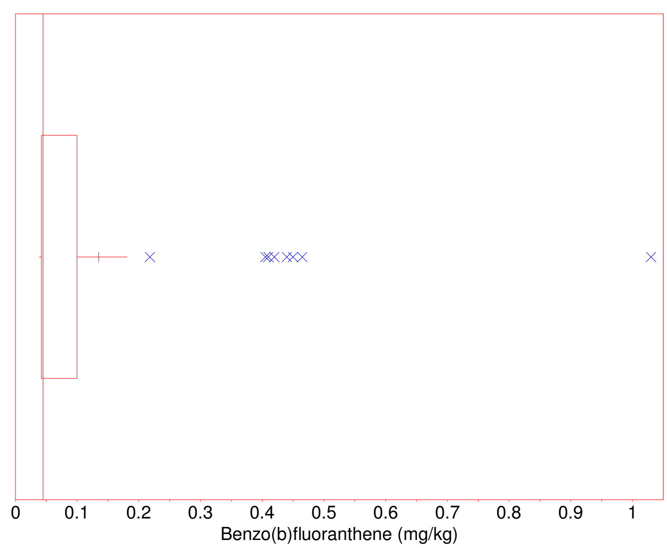
Data Plots for Benzo(b)fluoranthene
Graphical displays of the data are shown below.

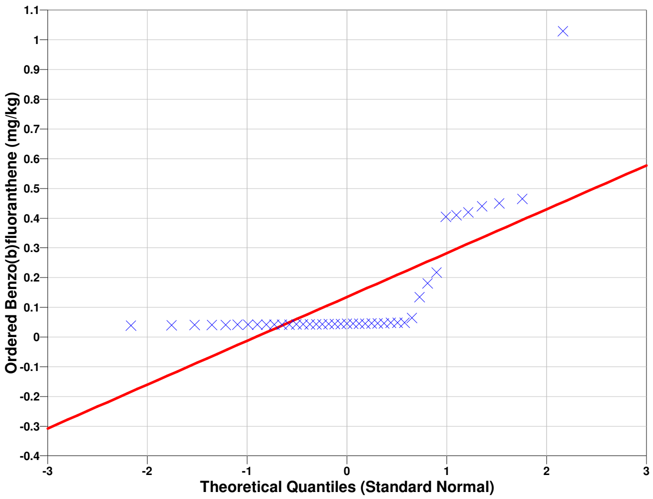
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Benzo(b)fluoranthene
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5433
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.1874
95% Non-Parametric (Chebyshev) UCL	0.2708

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.2708) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.1476),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-0.4097	1.6839	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
32	26	Reject

Data Analysis for Beryllium
The following data points were entered by the user for analysis.

Beryllium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0105	0.011	0.012	0.023	0.041	0.049	0.056	0.056	0.0706	0.074
10	0.075	0.078	0.087	0.092	0.094	0.1	0.11	0.12	0.13	0.13
20	0.14	0.15	0.16	0.19	0.2	0.2	0.2	0.22	0.22	0.23
30	0.24	0.27	0.31	0.34	0.37	0.38	0.46	0.49	0.52	0.52
40	0.89									

SUMMARY STATISTICS for Beryllium	
n	41
Min	0.0105
Max	0.89
Range	0.8795
Mean	0.19803
Median	0.14
Variance	0.03256
StdDev	0.18044
Std Error	0.028181
Skewness	1.8101
Interquartile Range	0.1805

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0105	0.0111	0.0266	0.0745	0.14	0.255	0.484	0.52	0.89

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Beryllium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.835	3.05	Yes

The test statistic 3.835 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Beryllium	
1	0.89

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8787
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

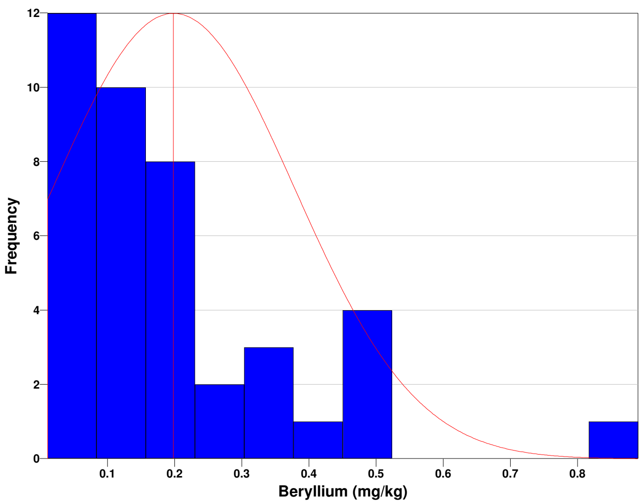
Data Plots for Beryllium
Graphical displays of the data are shown below.

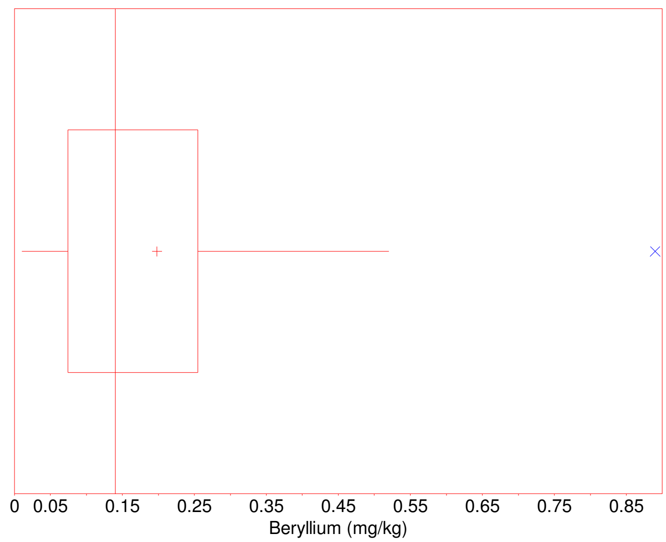
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

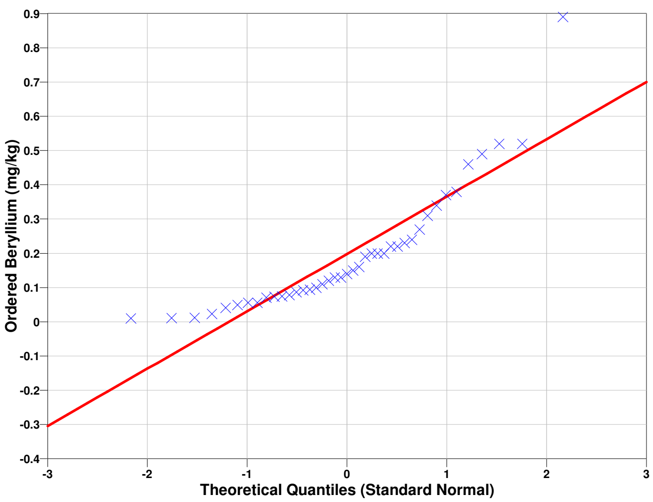
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the

Q-Q plot for an assumed normal distribution. The p^th^ quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Beryllium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8343
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.2455
95% Non-Parametric (Chebyshev) UCL	0.3209

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.3209) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.1476),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1326	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for bis(2-Ethylhexyl)phthalate
The following data points were entered by the user for analysis.

bis(2-Ethylhexyl)phthalate (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0455	0.047	0.0475	0.0485	0.0485	0.0485	0.0485	0.0485	0.049	0.0495
10	0.0495	0.0495	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20	0.05	0.054	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.075
30	0.117	0.15	0.269	0.37	0.384	0.475	0.485	0.495	0.5	0.525
40	0.55									

SUMMARY STATISTICS for bis(2-Ethylhexyl)phthalate	
n	41

Min	0.0455
Max	0.55
Range	0.5045
Mean	0.14302
Median	0.05
Variance	0.029212
StdDev	0.17091
Std Error	0.026692
Skewness	1.5437
Interquartile Range	0.084

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0455	0.04705	0.0485	0.0495	0.05	0.1335	0.493	0.5225	0.55

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for bis(2-Ethylhexyl)phthalate			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.381	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5668
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

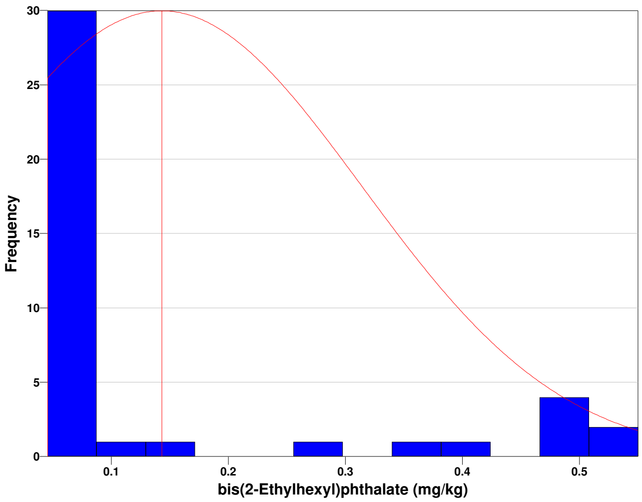
Data Plots for bis(2-Ethylhexyl)phthalate
Graphical displays of the data are shown below.

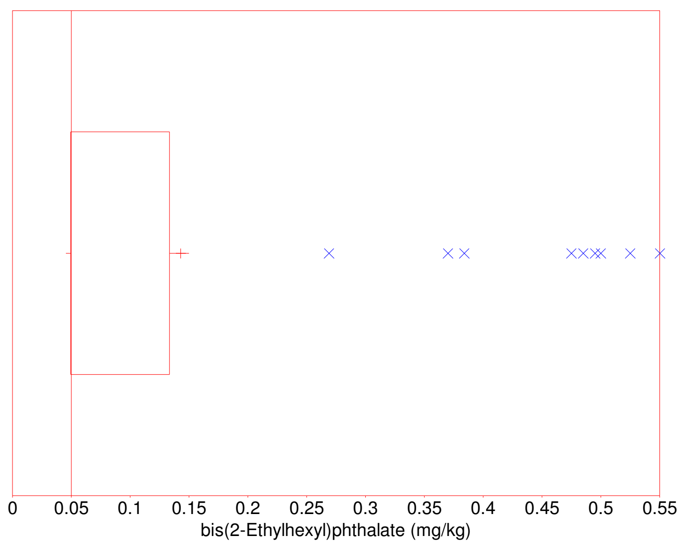
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each

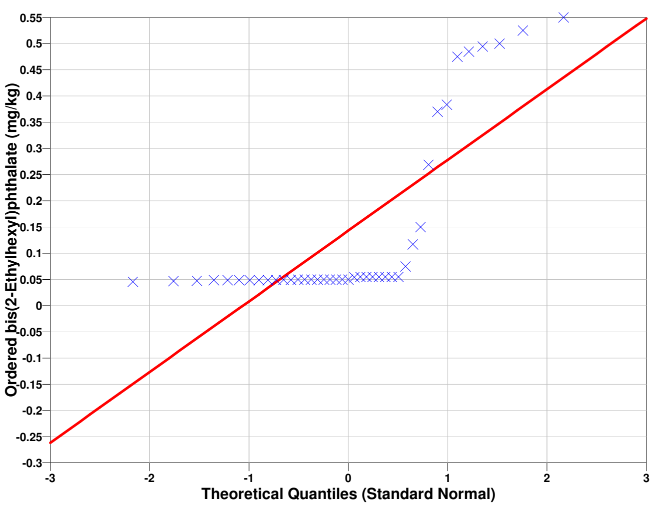
bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for bis(2-Ethylhexyl)phthalate
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5871
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.188
95% Non-Parametric (Chebyshev) UCL	0.2594

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.2594) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.1476),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1296.2	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Cadmium
The following data points were entered by the user for analysis.

Cadmium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0405	0.0418	0.043	0.045	0.046	0.047	0.0485	0.049	0.0495	0.05
10	0.05	0.0525	0.0525	0.0525	0.055	0.055	0.055	0.055	0.055	0.055
20	0.055	0.055	0.055	0.0575	0.0575	0.0575	0.06	0.06	0.06	0.06
30	0.06	0.065	0.065	0.07	0.12	0.14	0.17	0.19	0.23	0.56
40	1.1									

SUMMARY STATISTICS for Cadmium								
n	41							
Min	0.0405							
Max	1.1							
Range	1.0595							
Mean	0.10598							
Median	0.055							
Variance	0.032888							
StdDev	0.18135							
Std Error	0.028322							
Skewness	4.7306							
Interquartile Range	0.0125							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0405	0.04192	0.0452	0.05	0.055	0.0625	0.186	0.527	1.1

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Cadmium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.481	3.05	Yes

The test statistic 5.481 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Cadmium

1	1.1

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.4281
Shapiro-Wilk 5% Critical Value	0.94

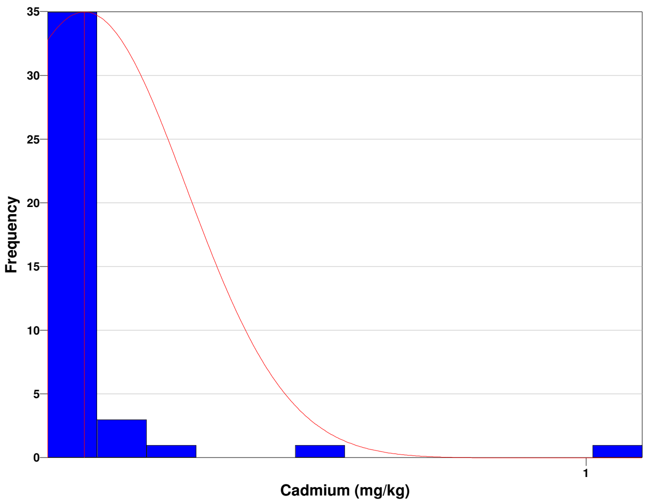
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

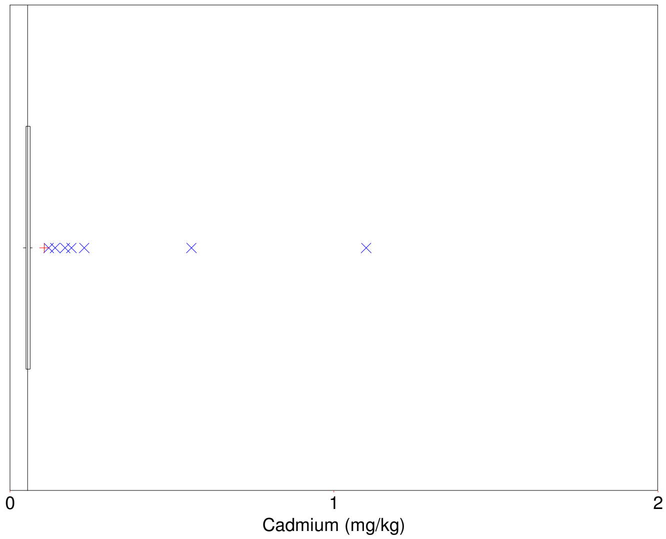
Data Plots for Cadmium
Graphical displays of the data are shown below.

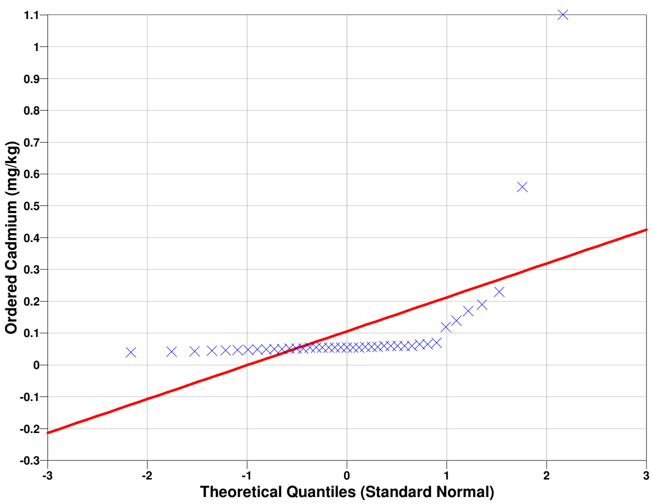
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Cadmium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.3646
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.1537

95% Non-Parametric (Chebyshev) UCL	0.2294

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.2294) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.1476),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1372.7	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Chromium
The following data points were entered by the user for analysis.

Chromium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.505	0.77	0.9	0.92	1.1	1.4	1.45	1.6	1.71	2
10	2.3	2.8	2.8	2.9	3.6	3.6	3.7	3.8	3.9	4
20	4	4.2	4.5	4.5	4.9	5.05	5.1	5.15	6.4	6.7
30	6.9	7.4	7.8	8.3	8.9	9	9.6	10.4	11.3	13.3
40	14.9									

SUMMARY STATISTICS for Chromium	
n	41
Min	0.505
Max	14.9

Range	14.395
Mean	4.977
Median	4
Variance	12.44
StdDev	3.527
Std Error	0.55082
Skewness	1.0011
Interquartile Range	5

Percentiles

1%	5%	10%	25%	50%	75%	90%	95%	99%
0.505	0.783	0.956	2.15	4	7.15	10.24	13.1	14.9

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Chromium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.813	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9271
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

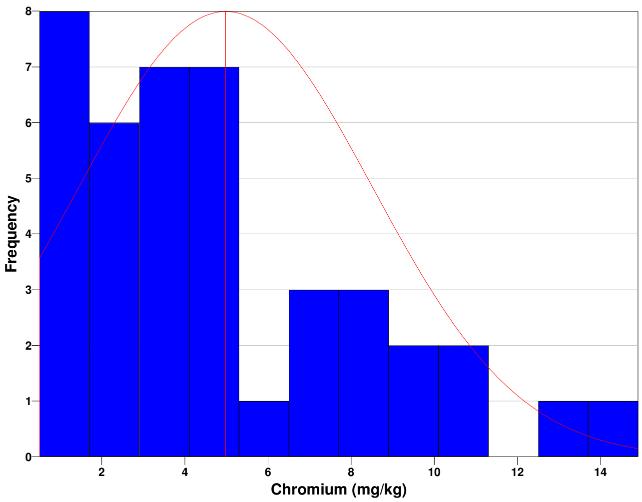
Data Plots for Chromium
Graphical displays of the data are shown below.

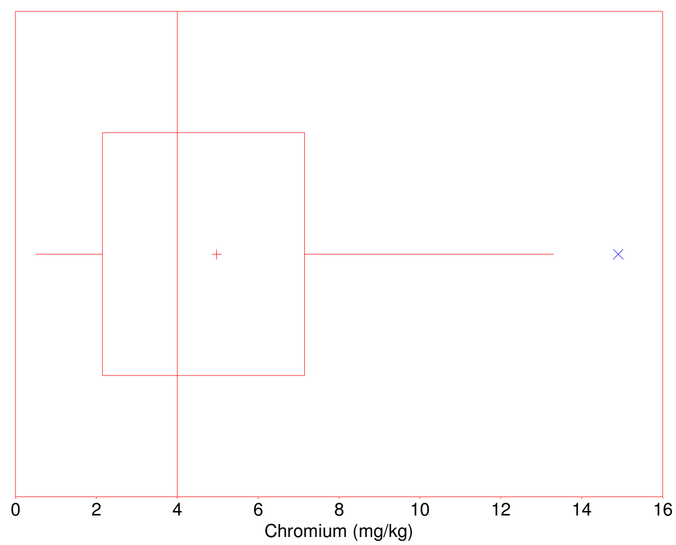
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally

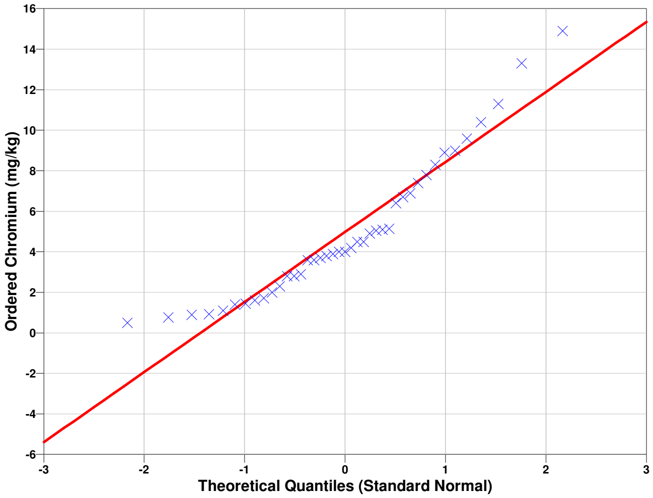
distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Chromium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was

conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9122
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	5.904
95% Non-Parametric (Chebyshev) UCL	7.378

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (7.378) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.1476),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-373.44	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Chromium_ Hexavalent
The following data points were entered by the user for analysis.

Chromium_ Hexavalent (mg/kg)

Rank	1	2	3	4	5	6	7	8	9	10
0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.55	0.6
10	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.625	0.65	0.65
20	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
30	0.7	0.7	0.7	0.9	1.2	1.3	1.3	1.4	1.8	1.9
40	3.1									

SUMMARY STATISTICS for Chromium_ Hexavalent								
n	41							
Min	0.5							
Max	3.1							
Range	2.6							
Mean	0.79939							
Median	0.65							
Variance	0.24908							
StdDev	0.49908							
Std Error	0.077943							
Skewness	3.1085							
Interquartile Range	0.1							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.5	0.5	0.5	0.6	0.65	0.7	1.38	1.89	3.1

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Chromium_ Hexavalent			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.61	3.05	Yes

The test statistic 4.61 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Chromium_ Hexavalent	
1	3.1

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the

suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6385
Shapiro-Wilk 5% Critical Value	0.94

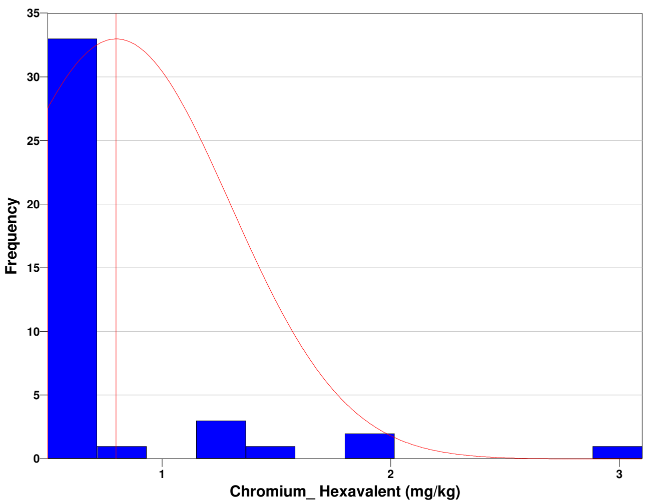
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

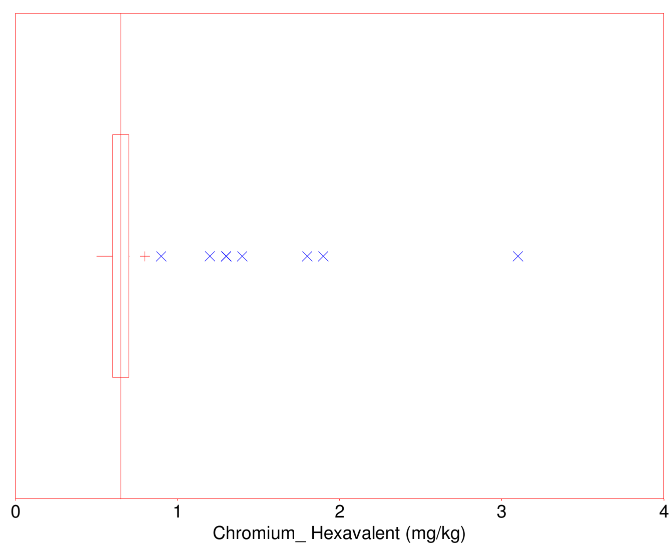
Data Plots for Chromium_ Hexavalent
Graphical displays of the data are shown below.

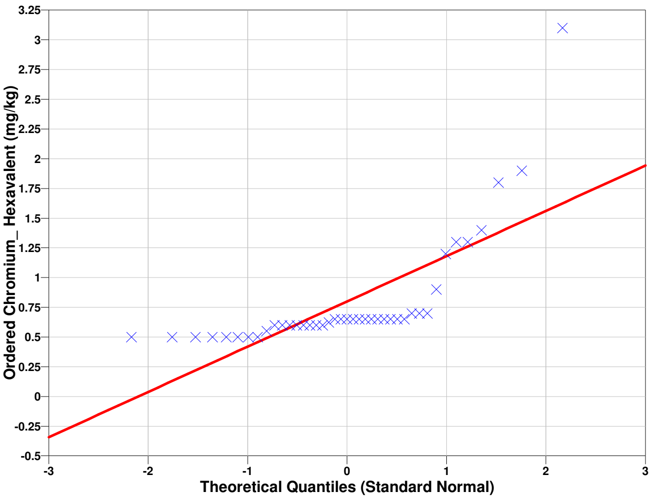
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Chromium_ Hexavalent
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5817
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.9306
95% Non-Parametric (Chebyshev) UCL	1.139

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (1.139) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.1476),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-375.88	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Chrysene
The following data points were entered by the user for analysis.

Chrysene (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.03	0.031	0.032	0.032	0.032	0.032	0.0325	0.0325	0.0325	0.0328
10	0.0328	0.033	0.0333	0.0335	0.0335	0.0335	0.034	0.0343	0.0345	0.0345
20	0.035	0.035	0.0353	0.0353	0.0355	0.036	0.0365	0.037	0.037	0.0375
30	0.0485	0.163	0.164	0.315	0.32	0.325	0.34	0.35	0.773	9.61
40	41.2									

SUMMARY STATISTICS for Chrysene								
n	41							
Min	0.03							
Max	41.2							
Range	41.17							
Mean	1.3323							
Median	0.035							
Variance	42.956							
StdDev	6.5541							
Std Error	1.0236							
Skewness	5.9612							
Interquartile Range	0.07295							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.03	0.0311	0.032	0.0328	0.035	0.1058	0.348	8.726	41.2

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Chrysene			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	6.083	3.05	Yes

The test statistic 6.083 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Chrysene	
1	41.2

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.21
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

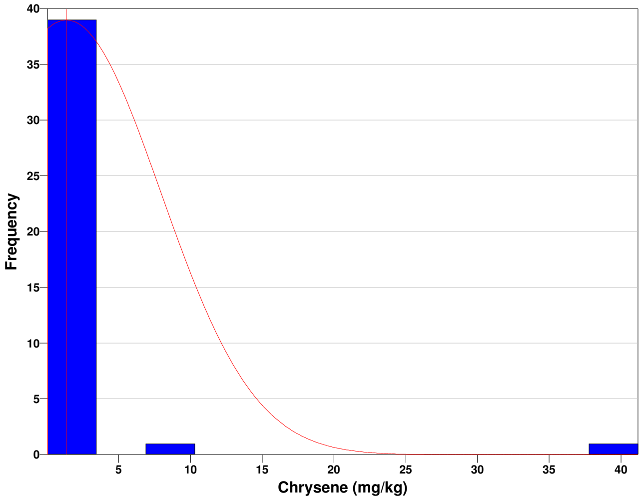
Data Plots for Chrysene
Graphical displays of the data are shown below.

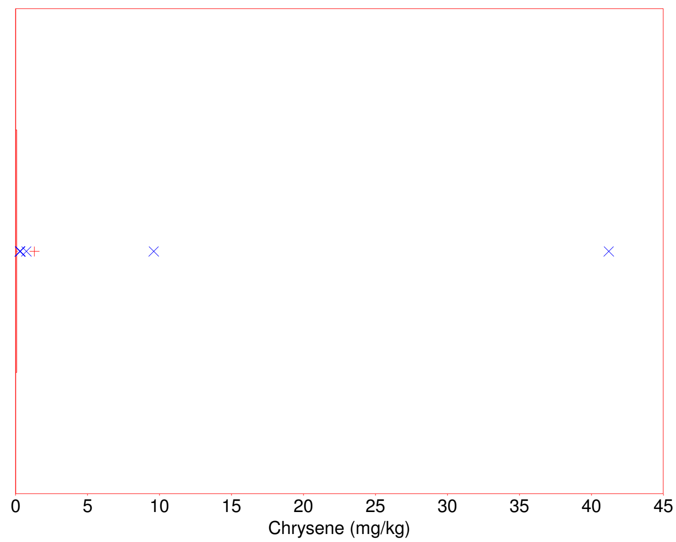
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

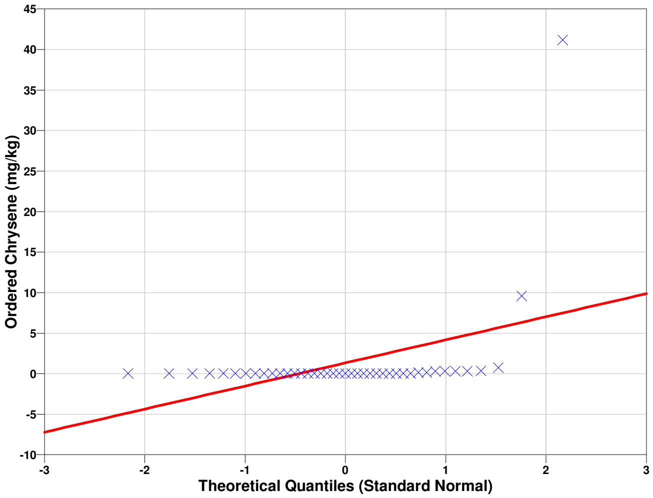
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the

Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Chrysene

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.2166
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	3.056
95% Non-Parametric (Chebyshev) UCL	5.794

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (5.794) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.1476),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-13.12	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
40	26	Reject

Data Analysis for Cobalt
The following data points were entered by the user for analysis.

Cobalt (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.08	0.095	0.1	0.108	0.19	0.2	0.36	0.43	0.44	0.464
10	0.47	0.53	0.61	0.62	0.71	0.74	1	1.1	1.1	1.2
20	1.3	1.3	1.3	1.3	1.3	1.45	1.45	1.5	1.55	1.6
30	1.7	1.7	1.8	2.2	2.3	2.5	2.5	2.8	3	3.3
40	4.6									

SUMMARY STATISTICS for Cobalt	
n	41

Min	0.08
Max	4.6
Range	4.52
Mean	1.2926
Median	1.3
Variance	0.99774
StdDev	0.99887
Std Error	0.156
Skewness	1.1633
Interquartile Range	1.233

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.08	0.0955	0.1244	0.467	1.3	1.7	2.74	3.27	4.6

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Cobalt			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.311	3.05	Yes

The test statistic 3.311 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Cobalt	
1	4.6

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9312
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

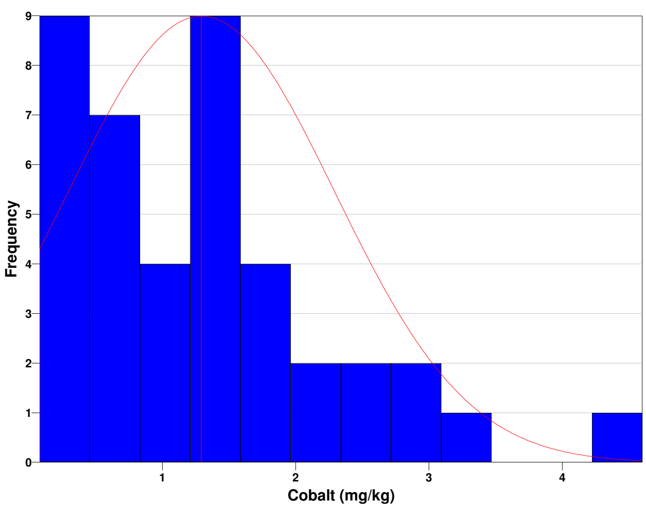
Data Plots for Cobalt

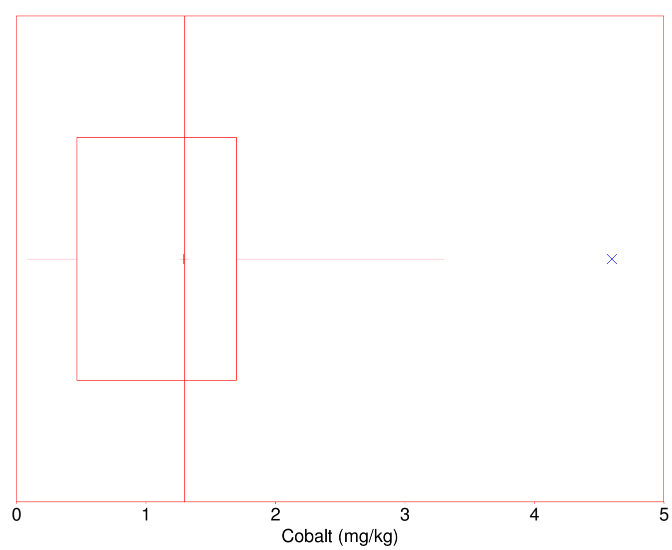
Graphical displays of the data are shown below.

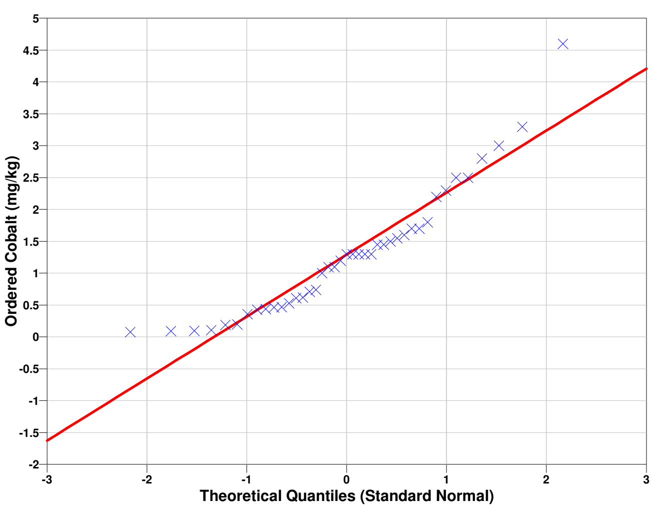
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Cobalt
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9087
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	1.555
95% Non-Parametric (Chebyshev) UCL	1.973

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (1.973) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.1476),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-5779.6	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**

41	26	Reject

Data Analysis for Copper
The following data points were entered by the user for analysis.

Copper (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.685	0.86	0.93	0.93	0.95	0.99	1	1.01	1.1	1.4
10	1.7	2.2	2.4	2.5	2.5	2.7	2.7	3.1	3.2	3.25
20	3.3	3.3	3.4	3.55	3.6	3.6	3.7	4.2	4.5	4.7
30	4.7	4.8	5.1	5.2	5.7	6.9	8.1	9.6	10.3	10.7
40	23.5									

SUMMARY STATISTICS for Copper								
n	41							
Min	0.685							
Max	23.5							
Range	22.815							
Mean	4.1111							
Median	3.3							
Variance	16.062							
StdDev	4.0077							
Std Error	0.62589							
Skewness	3.1509							
Interquartile Range	3.2							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.685	0.867	0.934	1.55	3.3	4.75	9.3	10.66	23.5

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Copper			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.838	3.05	Yes

The test statistic 4.838 exceeded the corresponding critical value, therefore that test is significant and we conclude that the

most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Copper	
1	23.5

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8635
Shapiro-Wilk 5% Critical Value	0.94

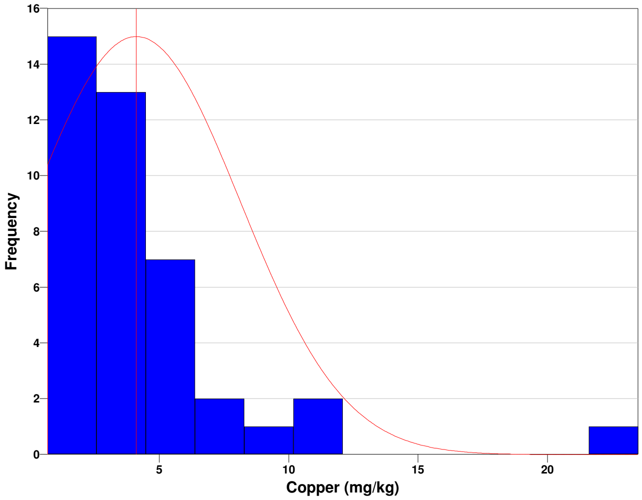
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

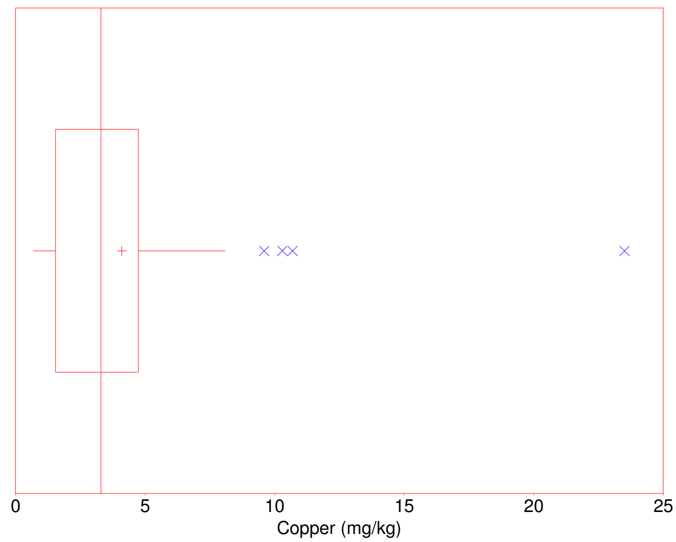
Data Plots for Copper
Graphical displays of the data are shown below.

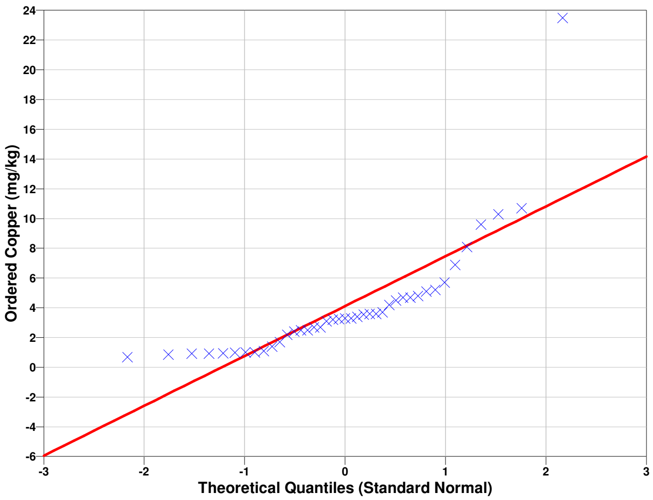
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Copper
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6979
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	5.165

95% Non-Parametric (Chebyshev) UCL	6.839

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (6.839) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.1476),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-868.33	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Isopropylbenzene
The following data points were entered by the user for analysis.

Isopropylbenzene (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00065	0.00065	0.00065	0.00065	0.00065	0.0007	0.0007	0.0007	0.0007	0.0007
10	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.000725
20	0.000725	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075
30	0.00075	0.00075	0.0008	0.0008	0.00085	0.00105	0.0014	0.00235	0.0048	0.0068
40	0.0227									

SUMMARY STATISTICS for Isopropylbenzene	
n	41
Min	0.00065
Max	0.0227

Range				0.02205				
Mean				0.0015683				
Median				0.000725				
Variance				1.2763e-005				
StdDev				0.0035726				
Std Error				0.00055794				
Skewness				5.5288				
Interquartile Range				5e-005				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00065	0.00065	0.00065	0.0007	0.000725	0.00075	0.00216	0.0066	0.0227

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Isopropylbenzene			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.915	3.05	Yes

The test statistic 5.915 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Isopropylbenzene	
1	0.0227

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.3501
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

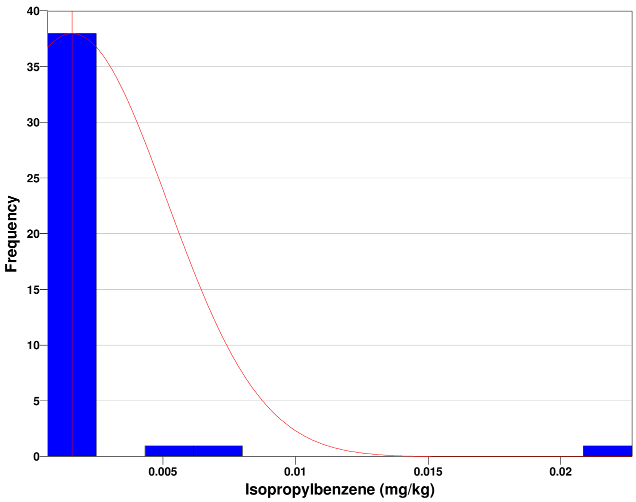
Data Plots for Isopropylbenzene
Graphical displays of the data are shown below.

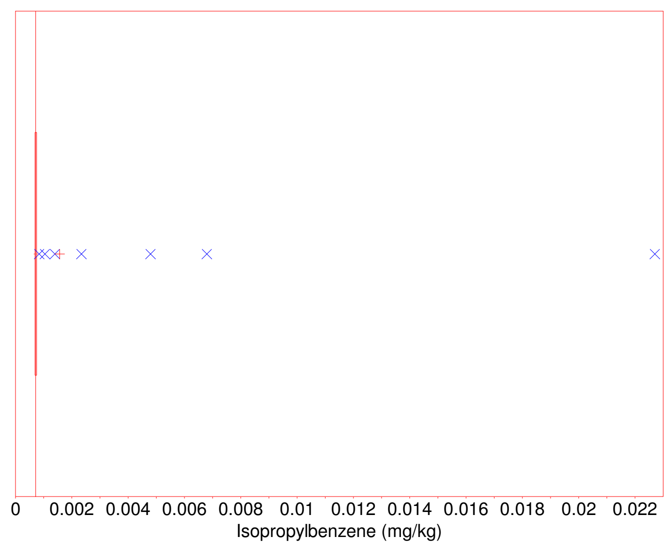
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

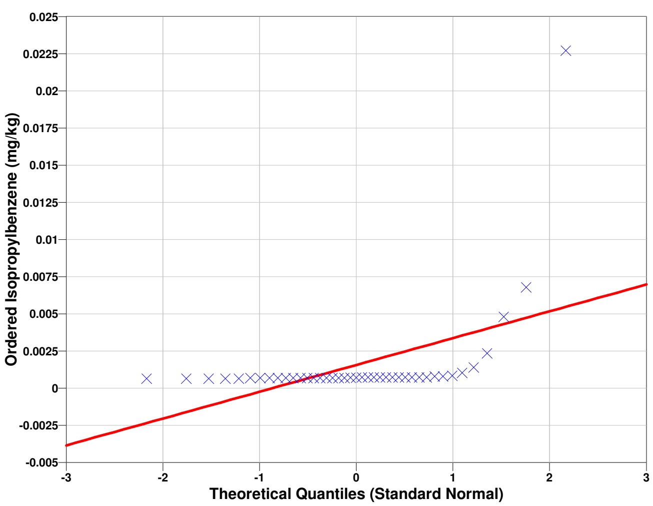
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Isopropylbenzene
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.2809
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.002508
95% Non-Parametric (Chebyshev) UCL	0.004

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.004) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.1476),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-6.6465e+005	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Lead
The following data points were entered by the user for analysis.

Lead (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	2.02	2.15	2.45	2.6	3.4	3.6	3.7	3.9	4.6	4.8
10	5.1	5.4	6	6.1	6.7	6.9	6.9	7	7.2	8
20	8.3	8.9	9.2	9.8	9.9	10.4	11.6	12.7	14.8	16.1
30	17.1	17.7	18.8	18.9	19.8	20.9	22.5	23.8	55.8	80.6
40	80.7									

SUMMARY STATISTICS for Lead	
n	41
Min	2.02
Max	80.7
Range	78.68
Mean	14.313
Median	8.3
Variance	320.07
StdDev	17.891
Std Error	2.794
Skewness	2.929
Interquartile Range	12.45

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
2.02	2.18	2.76	4.95	8.3	17.4	23.54	78.12	80.7

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Lead			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.711	3.05	Yes

The test statistic 3.711 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Lead

1	80.7

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6209
Shapiro-Wilk 5% Critical Value	0.94

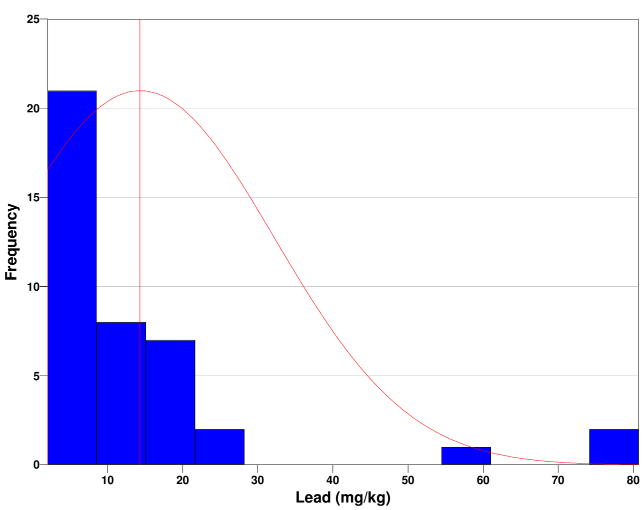
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

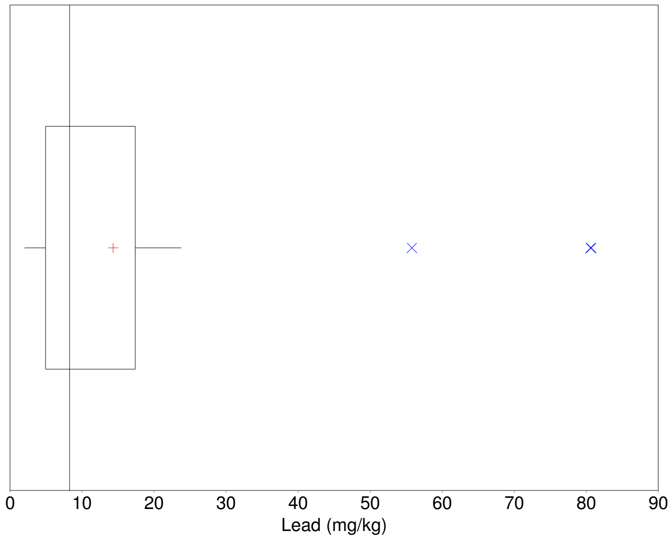
Data Plots for Lead
Graphical displays of the data are shown below.

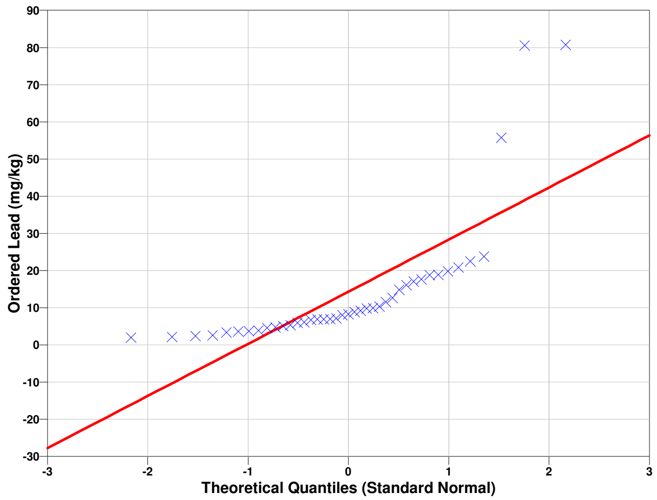
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Lead

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5993
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	19.02

95% Non-Parametric (Chebyshev) UCL	26.49

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (26.49) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.1476),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-138.04	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Manganese
The following data points were entered by the user for analysis.

Manganese (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	9.3	9.3	10	11.5	15.7	17.7	21.1	21.5	26.4	27.7
10	37.3	39.6	41	42.7	43.6	47.3	49.4	49.4	65.6	66.4
20	69.4	73.6	77	77.5	80.5	92	102	102	104	106
30	110	114	121	141	143	144	146	155	191	207
40	210									

SUMMARY STATISTICS for Manganese	
n	41
Min	9.3
Max	210

Range				200.7				
Mean				78.5				
Median				69.4				
Variance				3110.7				
StdDev				55.773				
Std Error				8.7103				
Skewness				0.73144				
Interquartile Range				79.5				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
9.3	9.37	12.34	32.5	69.4	112	153.2	205.4	210

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Manganese			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.358	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9278
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

Data Plots for Manganese
Graphical displays of the data are shown below.

The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally

distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

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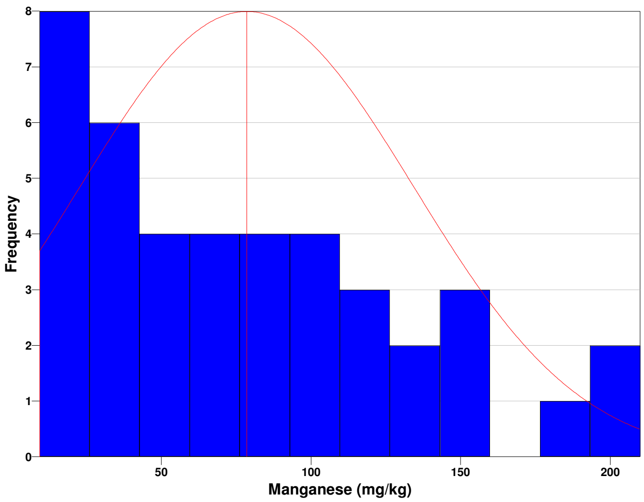

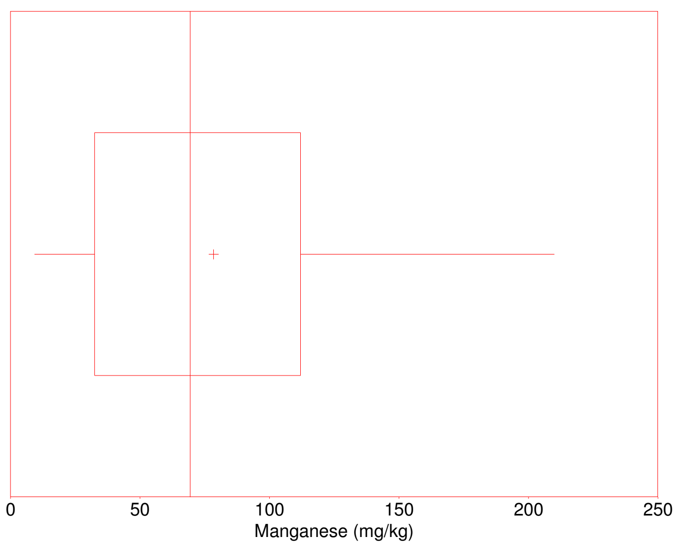

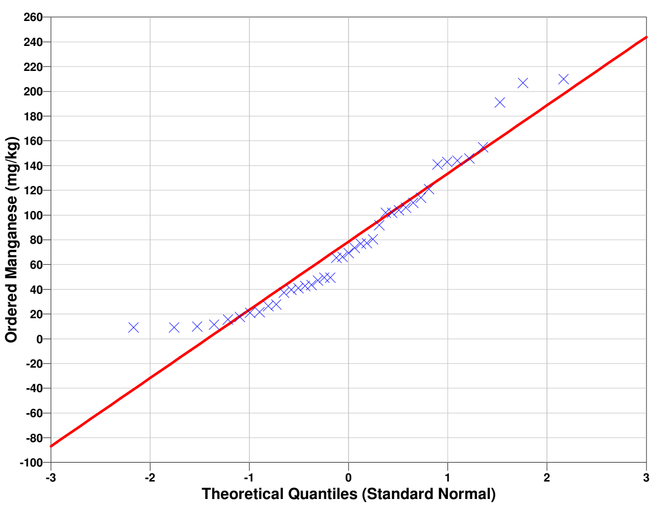

For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Manganese

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was

conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9178
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	93.17
95% Non-Parametric (Chebyshev) UCL	116.5

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (116.5) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.1476),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-362.88	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Mercury
The following data points were entered by the user for analysis.

Mercury (mg/kg)

Rank	1	2	3	4	5	6	7	8	9	10
0	0.000385	0.0013	0.0014	0.0014	0.0031	0.0037	0.0047	0.00535	0.0054	0.0054
10	0.0065	0.0069	0.007	0.007	0.0072	0.0073	0.0076	0.0079	0.0082	0.0083
20	0.0088	0.0093	0.0095	0.011	0.012	0.013	0.013	0.013	0.014	0.016
30	0.016	0.019	0.0215	0.024	0.024	0.026	0.034	0.034	0.049	0.079
40	0.74									

SUMMARY STATISTICS for Mercury								
n	41							
Min	0.000385							
Max	0.74							
Range	0.73962							
Mean	0.031515							
Median	0.0088							
Variance	0.013073							
StdDev	0.11434							
Std Error	0.017856							
Skewness	6.2472							
Interquartile Range	0.01155							
Percentiles								
1%	5%	10%	25%	50%	75%	90%	95%	99%
0.000385	0.00131	0.00174	0.00595	0.0088	0.0175	0.034	0.076	0.74

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Mercury			
k	Test Statistic R_k	5% Critical Value C_k	Significant?
1	6.197	3.05	Yes

The test statistic 6.197 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Mercury	
1	0.74

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the

suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7171
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

Data Plots for Mercury
Graphical displays of the data are shown below.

The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

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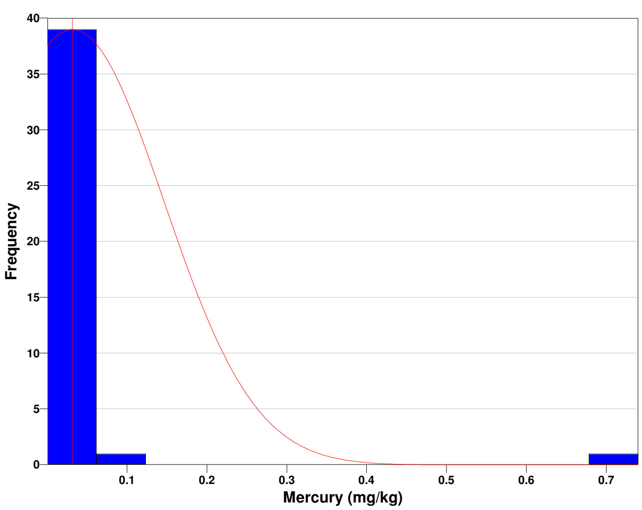
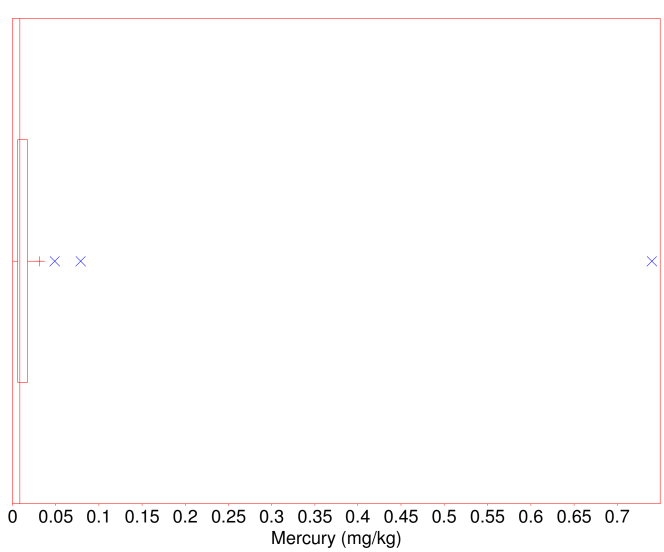
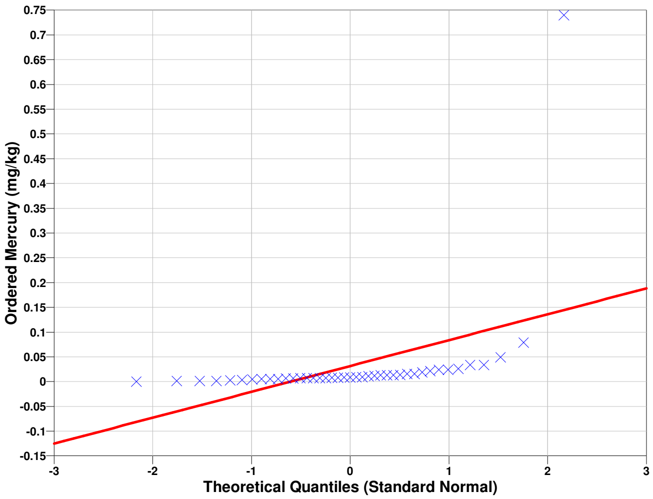






For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Mercury
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.2381
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.06158
95% Non-Parametric (Chebyshev) UCL	0.1093

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.1093) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.1476),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-115.13	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Methylene chloride
The following data points were entered by the user for analysis.

Methylene chloride (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0013	0.00135	0.0014	0.0014	0.0014	0.0014	0.00143	0.00145	0.00145	0.00145
10	0.00148	0.0015	0.0015	0.0015	0.00155	0.00155	0.00155	0.00155	0.00155	0.00155
20	0.00175	0.00215	0.0034	0.0035	0.0035	0.0038	0.004	0.004	0.0041	0.0043
30	0.0048	0.0048	0.0048	0.0069	0.0096	0.0114	0.0117	0.0134	0.0176	0.0235

SUMMARY STATISTICS for Methylene chloride								
n	40							
Min	0.0013							
Max	0.0235							
Range	0.0222							
Mean	0.0043078							
Median	0.00165							
Variance	2.4195e-005							
StdDev	0.0049188							
Std Error	0.00077773							
Skewness	2.4057							
Interquartile Range	0.0032175							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0013	0.001353	0.0014	0.001458	0.00165	0.004675	0.01167	0.01739	0.0235

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test

was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Methylene chloride			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.902	3.04	Yes

The test statistic 3.902 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Methylene chloride	
1	0.0235

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6777
Shapiro-Wilk 5% Critical Value	0.939

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

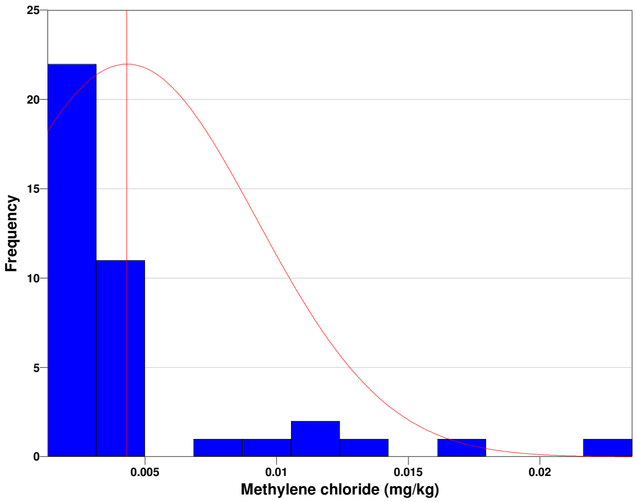
Data Plots for Methylene chloride
Graphical displays of the data are shown below.

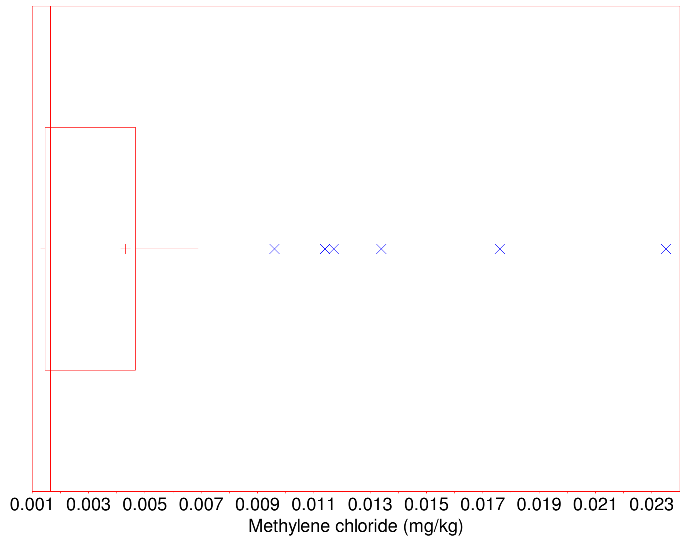
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

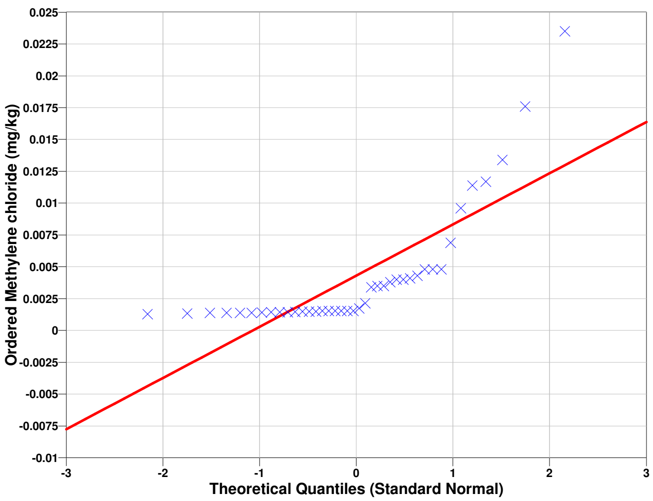
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight

line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Methylene chloride

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.651
Shapiro-Wilk 5% Critical Value	0.94

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN

95% Parametric UCL	0.005618
95% Non-Parametric (Chebyshev) UCL	0.007698

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.007698) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=40 data,
AL is the action level or threshold (0.1476),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=39 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1616	1.6849	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
40	25	Reject

Data Analysis for Nickel
The following data points were entered by the user for analysis.

Nickel (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0775	0.26	0.27	0.29	0.35	0.48	0.56	0.76	0.81	1
10	1.1	1.2	1.2	1.3	1.3	1.5	1.7	1.8	1.9	2
20	2.1	2.2	2.2	2.4	2.5	2.7	2.95	3.05	3.3	3.4
30	3.4	3.5	4.1	4.2	4.3	4.45	5.1	5.2	5.3	8.6
40	9.3									

SUMMARY STATISTICS for Nickel	
n	41
Min	0.0775

Max	9.3
Range	9.2225
Mean	2.5392
Median	2.1
Variance	4.3557
StdDev	2.087
Std Error	0.32594
Skewness	1.4641
Interquartile Range	2.4

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0775	0.261	0.302	1.05	2.1	3.45	5.18	8.27	9.3

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Nickel			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.239	3.05	Yes

The test statistic 3.239 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Nickel	
1	9.3

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9125
Shapiro-Wilk 5% Critical Value	0.94

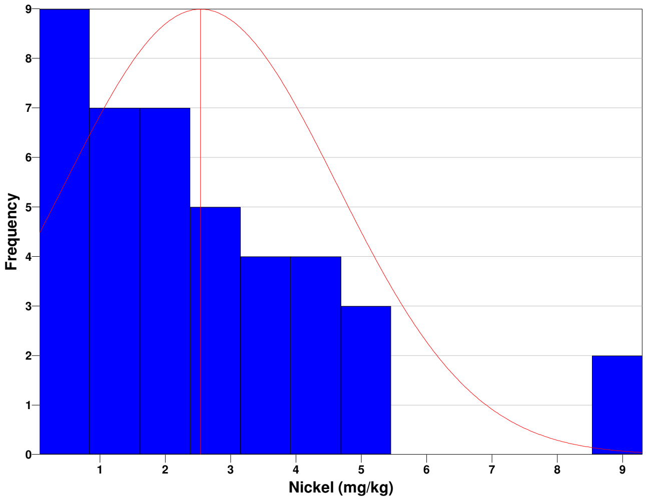
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

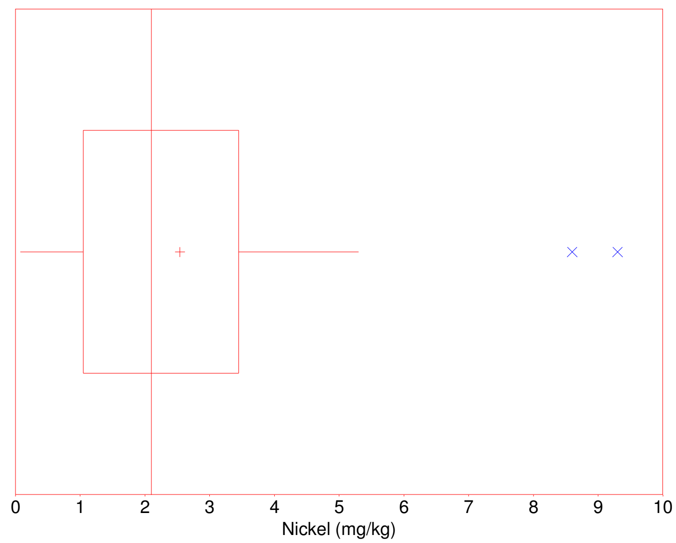
Data Plots for Nickel
Graphical displays of the data are shown below.

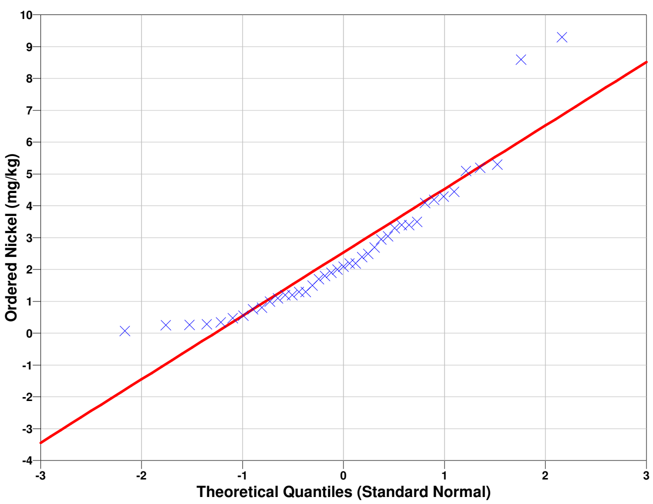
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through

2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Nickel
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8731
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	3.088
95% Non-Parametric (Chebyshev) UCL	3.96

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (3.96) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.1476),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-2545.2	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Phenanthrene
The following data points were entered by the user for analysis.

Phenanthrene (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.034	0.035	0.0355	0.036	0.036	0.036	0.0365	0.037	0.037	0.037
10	0.037	0.0375	0.0375	0.0378	0.038	0.038	0.038	0.0385	0.0388	0.039
20	0.039	0.0395	0.04	0.04	0.04	0.0405	0.041	0.041	0.042	0.042
30	0.0425	0.055	0.147	0.355	0.36	0.37	0.39	0.398	0.407	0.679
40	2.06									

SUMMARY STATISTICS for Phenanthrene								
n	41							
Min	0.034							
Max	2.06							
Range	2.026							
Mean	0.15631							
Median	0.039							
Variance	0.11605							
StdDev	0.34066							
Std Error	0.053202							
Skewness	4.6927							
Interquartile Range	0.01175							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.034	0.03505	0.036	0.037	0.039	0.04875	0.3964	0.6518	2.06

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Phenanthrene			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.588	3.05	Yes

The test statistic 5.588 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Phenanthrene

1	2.06

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5336
Shapiro-Wilk 5% Critical Value	0.94

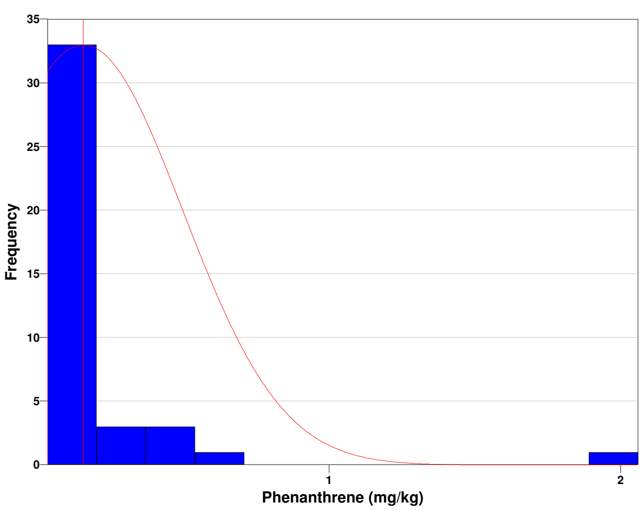
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

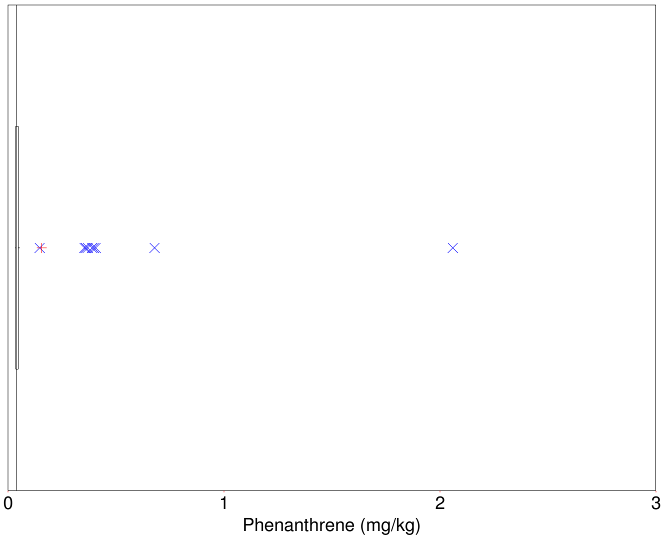
Data Plots for Phenanthrene
Graphical displays of the data are shown below.

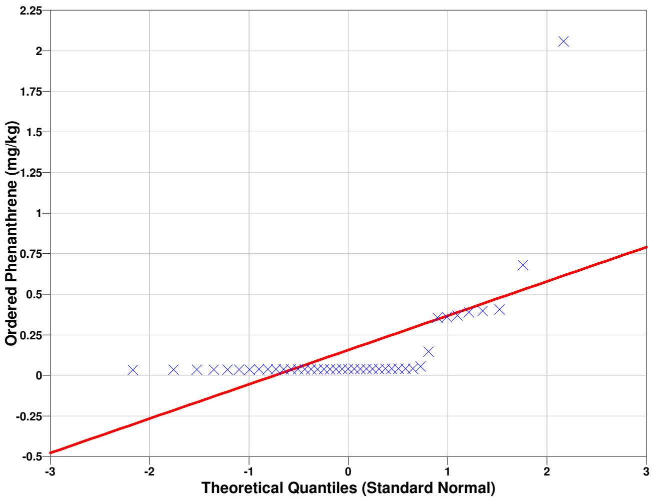
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Phenanthrene
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.4048
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.2459

95% Non-Parametric (Chebyshev) UCL	0.3882

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.3882) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.1476),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-32049	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Pyrene
The following data points were entered by the user for analysis.

Pyrene (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0445	0.046	0.0475	0.0475	0.0475	0.048	0.048	0.0485	0.0485	0.0485
10	0.049	0.049	0.0495	0.0498	0.05	0.05	0.05	0.05	0.05	0.05
20	0.05	0.05	0.0525	0.0535	0.055	0.055	0.055	0.055	0.055	0.055
30	0.07	0.237	0.336	0.355	0.465	0.475	0.485	0.5	0.525	0.55
40	1.58									

SUMMARY STATISTICS for Pyrene	
n	41
Min	0.0445
Max	1.58

Range				1.5355				
Mean				0.17282				
Median				0.05				
Variance				0.078826				
StdDev				0.28076				
Std Error				0.043847				
Skewness				3.5104				
Interquartile Range				0.10475				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0445	0.04615	0.0475	0.04875	0.05	0.1535	0.497	0.5475	1.58

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Pyrene			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.012	3.05	Yes

The test statistic 5.012 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Pyrene	
1	1.58

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5639
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

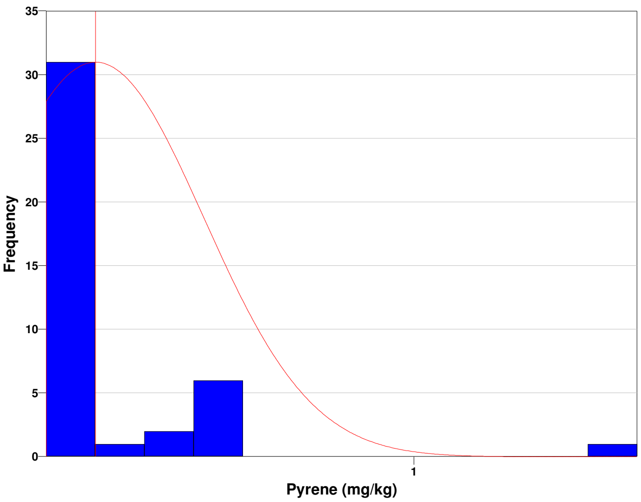
Data Plots for Pyrene
Graphical displays of the data are shown below.

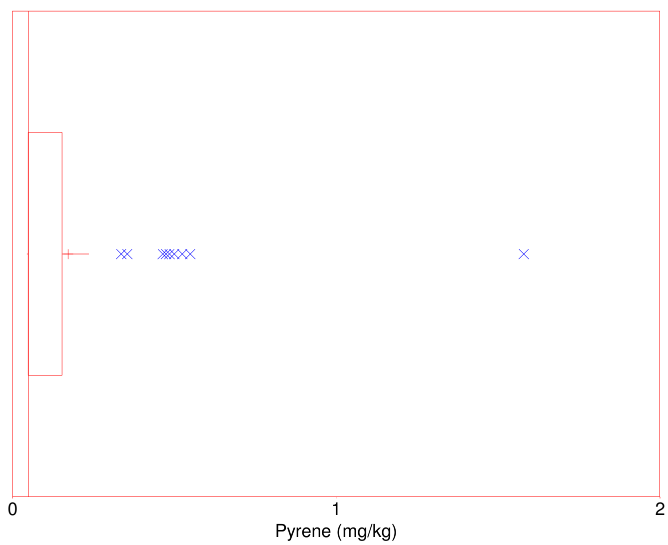
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

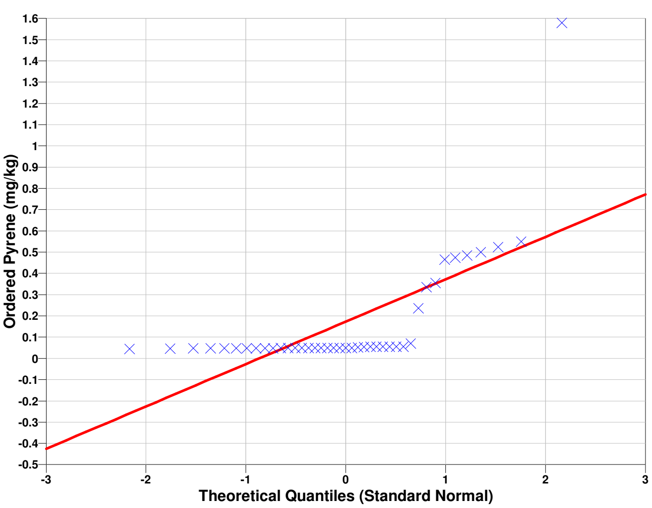
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Pyrene

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5125
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.2467
95% Non-Parametric (Chebyshev) UCL	0.3639

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.3639) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test

A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where

x is the sample mean of the n=41 data,

AL is the action level or threshold (0.1476),

SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-38713	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Toluene
The following data points were entered by the user for analysis.

Toluene (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00065	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.00075	0.00075
10	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.000775	0.0008
20	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
30	0.0008	0.0008	0.0008	0.00085	0.00085	0.0009	0.0011	0.0014	0.0015	0.0039
40	0.0044									

SUMMARY STATISTICS for Toluene	
n	41
Min	0.00065
Max	0.0044
Range	0.00375
Mean	0.00097378
Median	0.0008
Variance	5.6012e-007
StdDev	0.00074841
Std Error	0.00011688
Skewness	4.0831
Interquartile Range	5e-005

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00065	0.0007	0.0007	0.00075	0.0008	0.0008	0.00134	0.00366	0.0044

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Toluene			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.578	3.05	Yes

The test statistic 4.578 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Toluene

1	0.0044

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.3454
Shapiro-Wilk 5% Critical Value	0.94

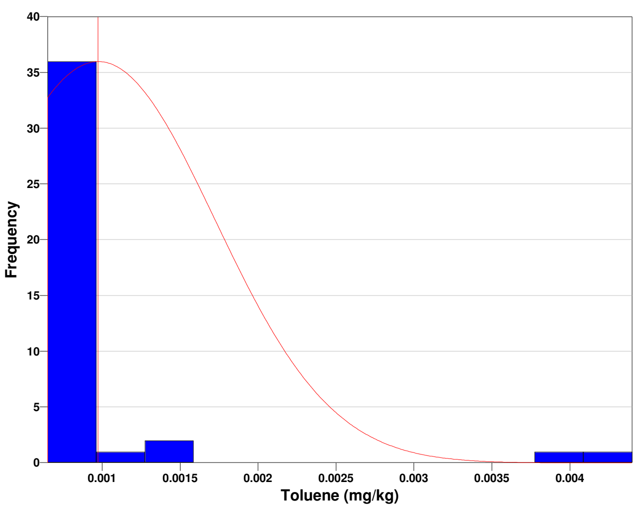
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

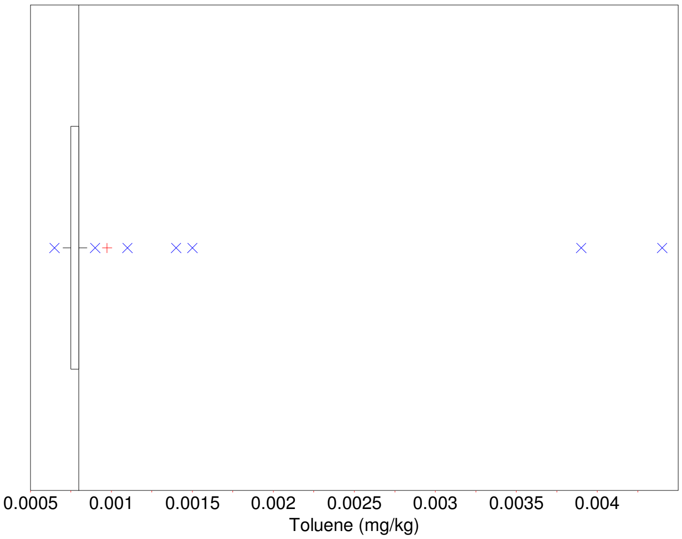
Data Plots for Toluene
Graphical displays of the data are shown below.

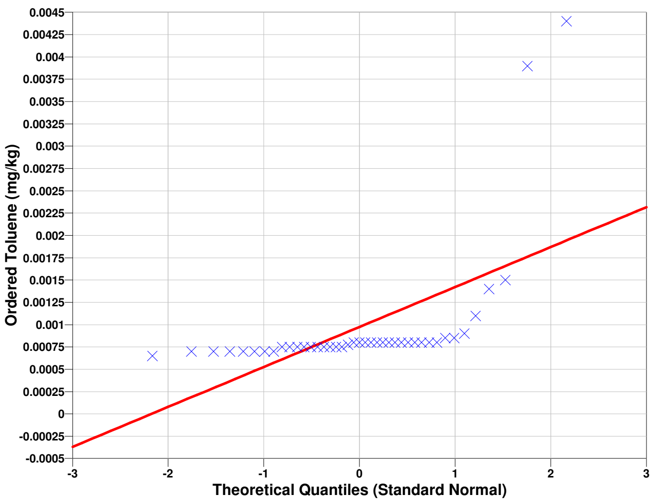
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Toluene
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.3684
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.001171

95% Non-Parametric (Chebyshev) UCL	0.001483

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.001483) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.1476),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-4.4589e+006	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Vanadium
The following data points were entered by the user for analysis.

Vanadium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.985	1.1	1.1	1.3	1.6	1.7	2.1	2.3	2.4	2.4
10	2.93	3.5	4.1	4.1	4.5	4.7	4.8	4.9	5.1	5.1
20	5.25	5.8	6.1	6.6	6.85	7	7.7	7.8	9.1	9.6
30	10.5	10.6	12.8	13.2	15.8	16	16.2	16.6	17.3	22.3
40	29.3									

SUMMARY STATISTICS for Vanadium	
n	41
Min	0.985
Max	29.3

Range				28.315				
Mean				7.637				
Median				5.25				
Variance				40.719				
StdDev				6.3812				
Std Error				0.99657				
Skewness				1.4668				
Interquartile Range				7.885				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.985	1.1	1.36	2.665	5.25	10.55	16.52	21.8	29.3

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Vanadium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.395	3.05	Yes

The test statistic 3.395 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Vanadium	
1	29.3

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8818
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

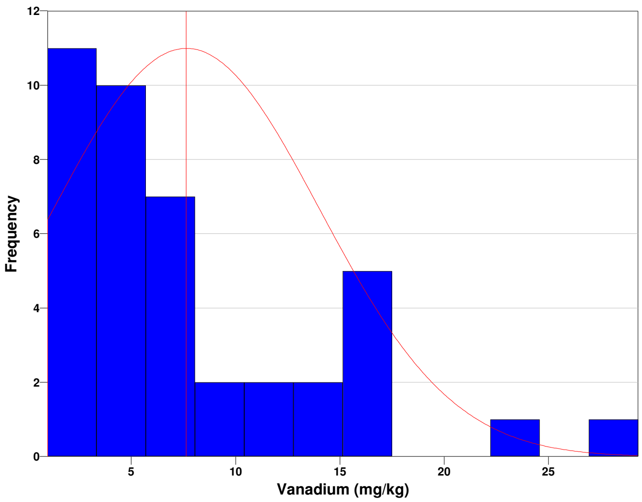
Data Plots for Vanadium
Graphical displays of the data are shown below.

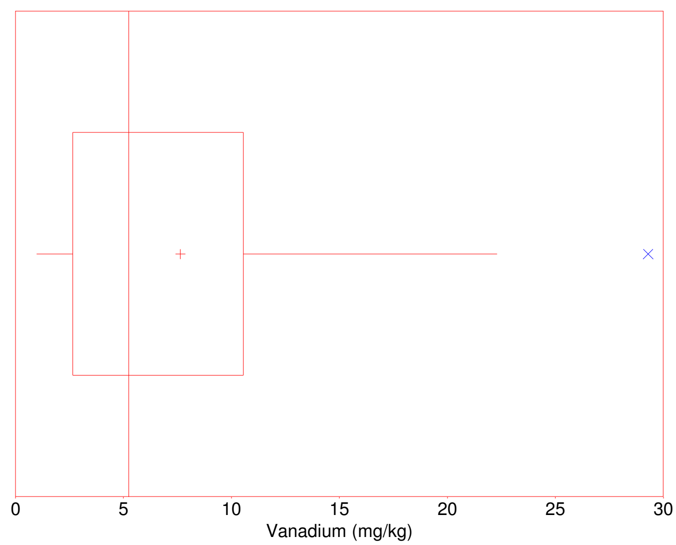
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

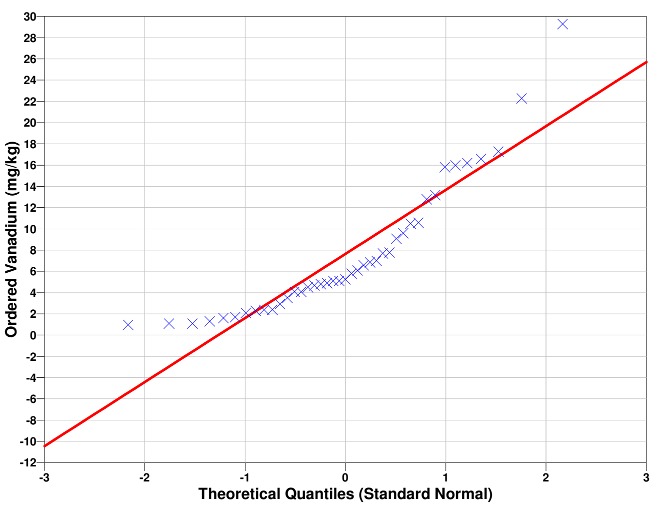
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Vanadium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8548
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	9.315
95% Non-Parametric (Chebyshev) UCL	11.98

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (11.98) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.1476),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-284.35	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Xylene (total)
The following data points were entered by the user for analysis.

Xylene (total) (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.002	0.00205	0.00205	0.00205	0.00215	0.00215	0.00215	0.00215	0.00215	0.0022
10	0.0022	0.0022	0.0022	0.00225	0.00225	0.0023	0.0023	0.0023	0.0023	0.00235
20	0.00235	0.00235	0.00235	0.00238	0.00238	0.0024	0.0024	0.0024	0.0024	0.00245
30	0.0025	0.0026	0.00265	0.0033	0.0047	0.0048	0.005	0.0056	0.0057	0.0062
40	0.0077									

SUMMARY STATISTICS for Xylene (total)								
n	41							
Min	0.002							
Max	0.0077							
Range	0.0057							
Mean	0.0028868							
Median	0.00235							
Variance	1.8443e-006							
StdDev	0.0013581							
Std Error	0.00021209							
Skewness	2.1404							
Interquartile Range	0.00035							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.002	0.00205	0.00207	0.0022	0.00235	0.00255	0.00548	0.00615	0.0077

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Xylene (total)			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.544	3.05	Yes

The test statistic 3.544 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Xylene (total)

1	0.0077

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5979
Shapiro-Wilk 5% Critical Value	0.94

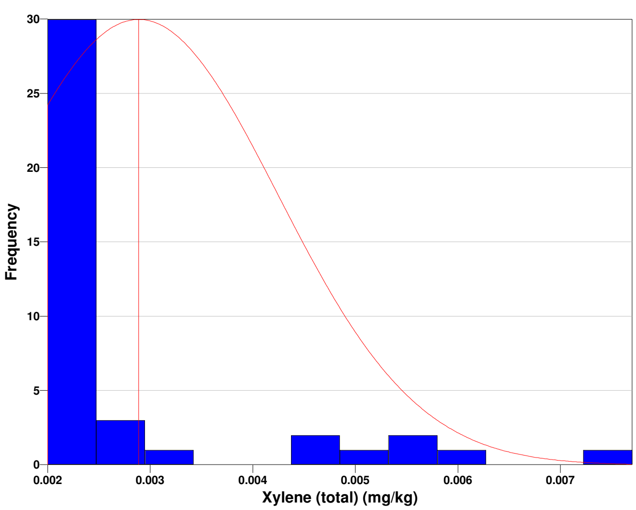
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

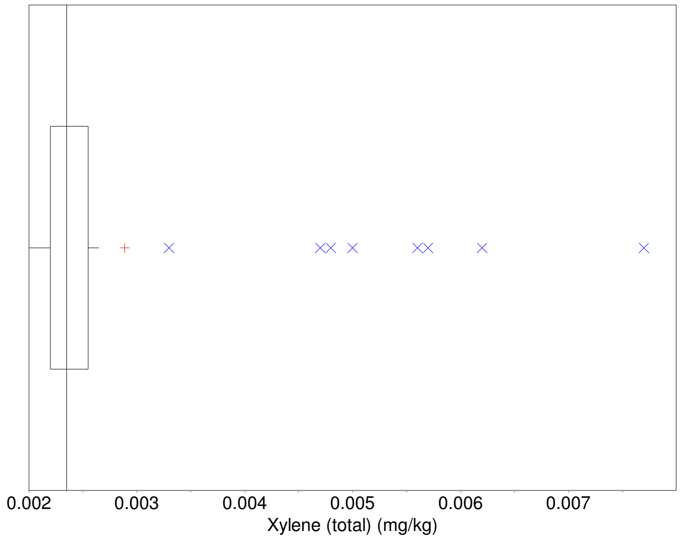
Data Plots for Xylene (total)
Graphical displays of the data are shown below.

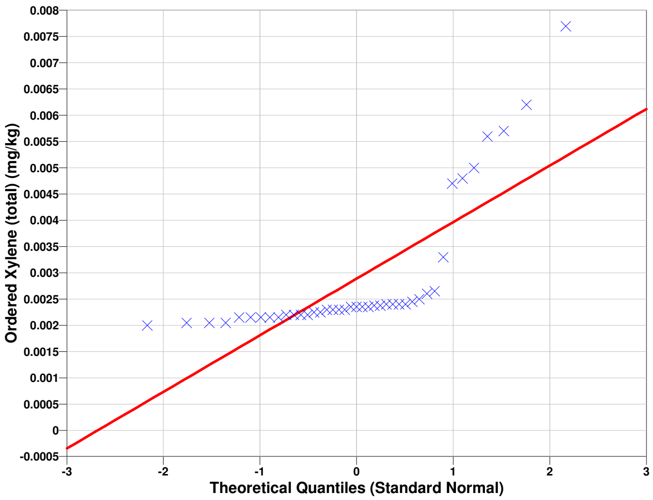
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Xylene (total)
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6112
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.003244

95% Non-Parametric (Chebyshev) UCL	0.003811

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.003811) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.1476),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.0112e+006	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Zinc
The following data points were entered by the user for analysis.

Zinc (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	3.1	6.1	8.7	10.4	10.6	11.1	12.2	16.6	17.2	19.7
10	20.1	22.2	22.8	23.6	25.2	25.9	26.1	26.2	29.4	29.8
20	30.2	31.1	31.8	35	39.5	40.2	40.7	40.7	44.1	48
30	48.5	59	59	79	80.3	85.3	92.6	129	143	156
40	232									

SUMMARY STATISTICS for Zinc	
n	41
Min	3.1
Max	232

Range	228.9
Mean	46.634
Median	30.2
Variance	2169.2
StdDev	46.575
Std Error	7.2737
Skewness	2.2859
Interquartile Range	33.85

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
3.1	6.36	10.44	19.9	30.2	53.75	121.7	154.7	232

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Zinc			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.98	3.05	Yes

The test statistic 3.98 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Zinc	
1	232

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.799
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

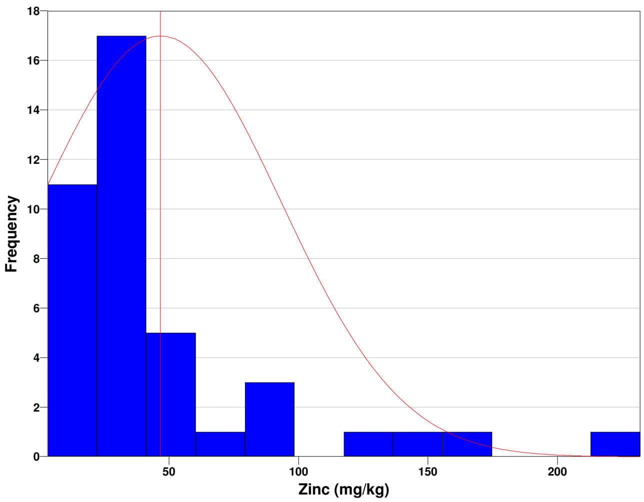
Data Plots for Zinc
Graphical displays of the data are shown below.

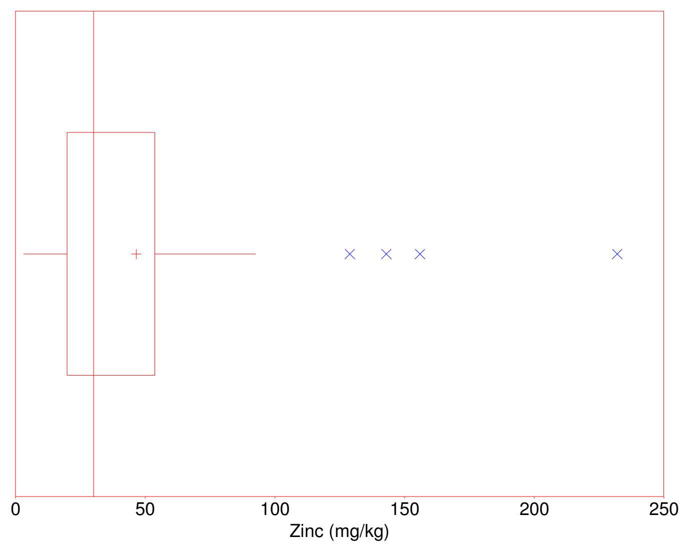
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

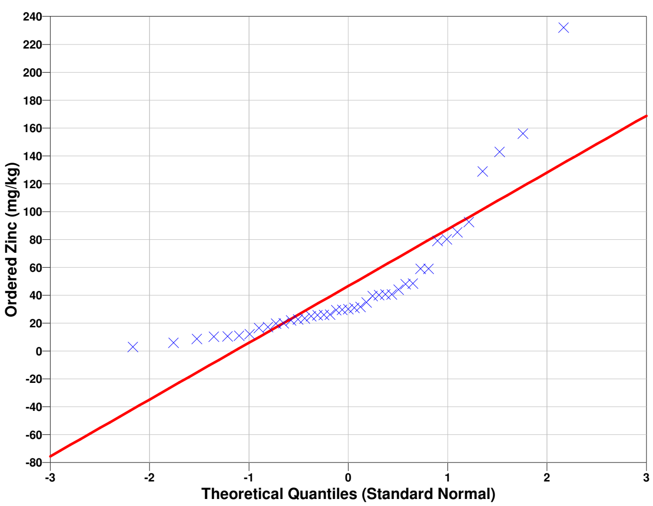
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Zinc
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7459
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	58.88
95% Non-Parametric (Chebyshev) UCL	78.34

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (78.34) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.1476),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1357.6	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Appendix C

VSP Reports of Calculated Minimum Sample Quantity
Report 2
Area of Concern – 1
Minimum Sample Quantity Calculation for Surface Soil using Human Health Benchmarks and Delta Method 2

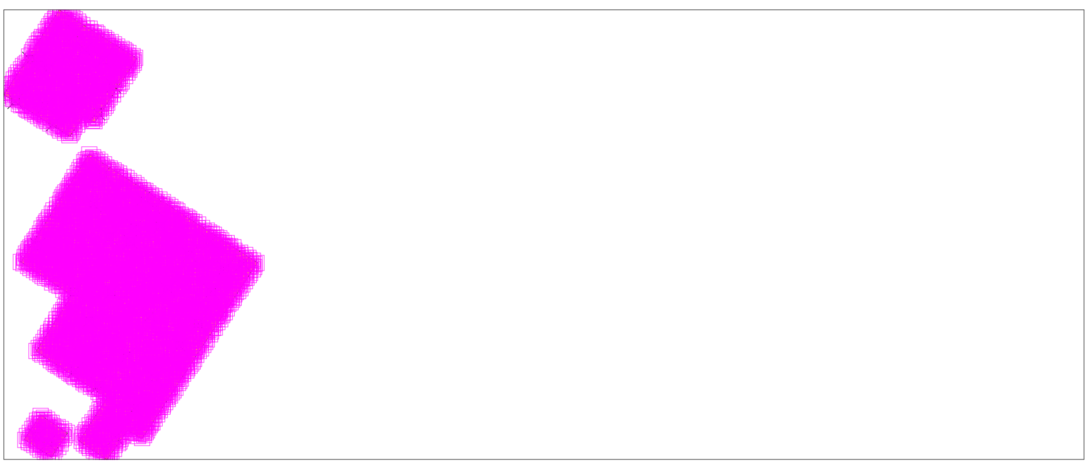
Random sampling locations for comparing a mean with a fixed threshold (parametric)

Summary
This report summarizes the sampling design, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design for Benzo(a)pyrene, the driving analyte (the analyte which required the largest number of samples). A figure that shows sampling locations in the field is also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean to a fixed threshold
Type of Sampling Design	Parametric
Sample Placement (Location) in the Field	Simple random sampling
Working (Null) Hypothesis	The mean value at the site exceeds the threshold
Formula for calculating number of sampling locations	Student's t-test
Calculated total number of samples	5087
Number of samples on map [a]	5087
Number of selected sample areas [b]	1
Specified sampling area [c]	188054.34 m^2
Total cost of sampling [d]	$2,544,500.00

[a] This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[d] Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.



Primary Sampling Objective
The primary purpose of sampling at this site is to compare a mean value of a site with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the mean value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the mean value is less than the threshold. VSP calculates the number of samples required to reject the

null hypothesis in favor of the alternative hypothesis, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach
A parametric random sampling approach was used to determine the number of samples and to specify sampling locations. A parametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that parametric assumptions are reasonable. These assumptions will be examined in post-sampling data analysis.

Both parametric and non-parametric approaches rely on assumptions about the population. However, non-parametric approaches typically require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than the number of samples required by non-parametric approaches.

Locating the sample points randomly provides data that are separated by many distances, whereas systematic samples are all equidistant apart. Therefore, random sampling provides more information about the spatial structure of the potential contamination than systematic sampling does. As with systematic sampling, random sampling also provides information regarding the mean value, but there is the possibility that areas of the site will not be represented with the same frequency as if uniform grid sampling were performed.

Number of Total Samples: Calculation Equation and Inputs
The equation used to calculate the number of samples is based on a Student's t-test. For this site, the null hypothesis is rejected in favor of the alternative hypothesis if the sample mean is sufficiently smaller than the threshold. The number of samples to collect is calculated so that 1) there will be a high probability ($1-\beta$) of rejecting the null hypothesis if the alternative hypothesis is true and 2) a low probability (α) of rejecting the null hypothesis if the null hypothesis is true.

The formula used to calculate the number of samples is:

$$n = \frac{S^2}{\Delta^2}\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2 + 0.5Z_{1-\alpha}^2$$

where
n is the number of samples,
S is the estimated standard deviation of the measured values including analytical error,
Δ is the width of the gray region,
α is the acceptable probability of incorrectly concluding the site mean is less than the threshold,
β is the acceptable probability of incorrectly concluding the site mean exceeds the threshold,
$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is $1-\alpha$,
$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is $1-\beta$.

The values of these inputs that result in the calculated number of sampling locations are:

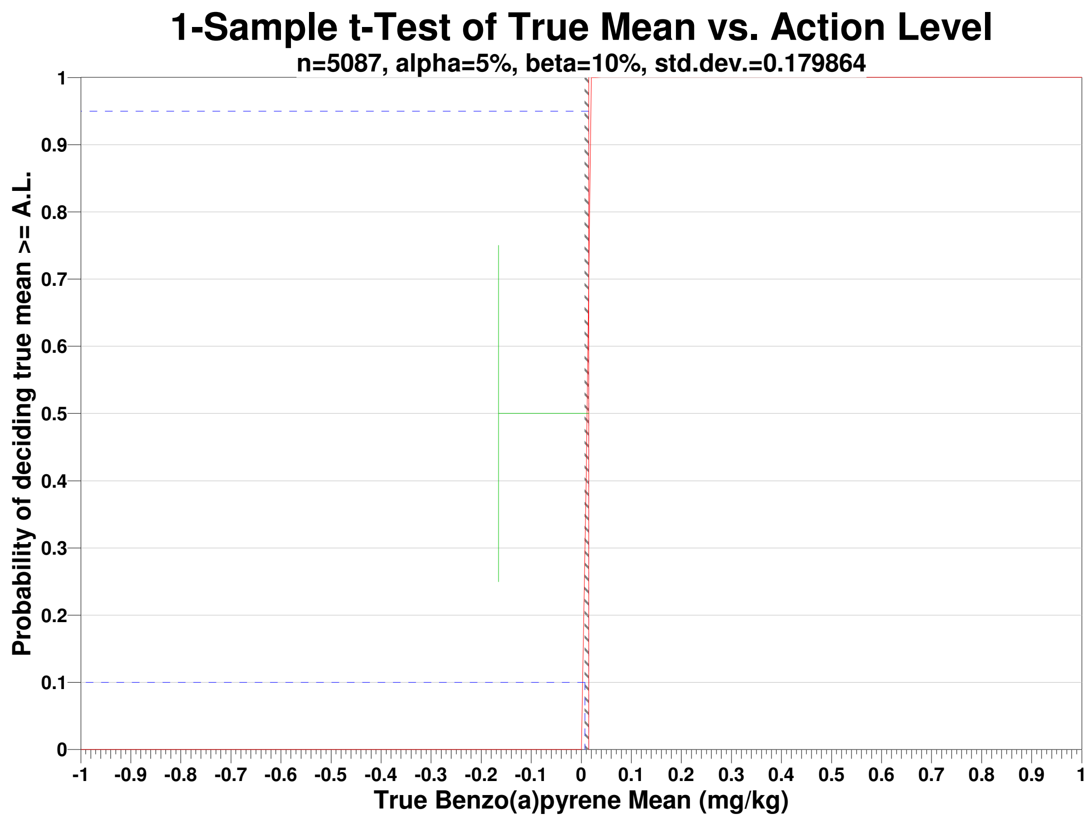
Analyte	n	Parameter					
		S	Δ	α	β	$Z_{1-\alpha}$ [a]	$Z_{1-\beta}$ [b]
New Location	2	0.1 mg/kg	10 mg/kg	0.05	0.1	1.64485	1.28155
1_2_4-Trimethylbenzene	2	0.00059013 mg/kg	26.0725 mg/kg	0.05	0.1	1.64485	1.28155
Acetone	2	0.0152671 mg/kg	2708.71 mg/kg	0.05	0.1	1.64485	1.28155
Aluminum	23	5176.14 mg/kg	3260.58 mg/kg	0.05	0.1	1.64485	1.28155
Arsenic	184	0.899292 mg/kg	0.194812 mg/kg	0.05	0.1	1.64485	1.28155
Barium	2	234.679 mg/kg	3920.25 mg/kg	0.05	0.1	1.64485	1.28155
Benzo(a)anthracene	741	0.685504 mg/kg	0.0738094 mg/kg	0.05	0.1	1.64485	1.28155
Benzo(a)pyrene	5087	0.179864 mg/kg	0.00738094 mg/kg	0.05	0.1	1.64485	1.28155
Benzo(b)fluoranthene	65	0.199783 mg/kg	0.0738 mg/kg	0.05	0.1	1.64485	1.28155
Beryllium	2	0.180444 mg/kg	18.7822 mg/kg	0.05	0.1	1.64485	1.28155

bis(2-Ethylhexyl)phthalate	2	0.170899 mg/kg	17.3707 mg/kg	0.05	0.1	1.64485	1.28155
Cadmium	2	0.181351 mg/kg	19.4925 mg/kg	0.05	0.1	1.64485	1.28155
Chromium	2	3.52689 mg/kg	105.338 mg/kg	0.05	0.1	1.64485	1.28155
Chromium_ Hexavalent	2	0.499077 mg/kg	15.0482 mg/kg	0.05	0.1	1.64485	1.28155
Chrysene	9	6.5541 mg/kg	7.38094 mg/kg	0.05	0.1	1.64485	1.28155
Cobalt	2	0.998894 mg/kg	451.447 mg/kg	0.05	0.1	1.64485	1.28155
Copper	2	4.00774 mg/kg	273.798 mg/kg	0.05	0.1	1.64485	1.28155
Isopropylbenzene	2	0.00356517 mg/kg	185.419 mg/kg	0.05	0.1	1.64485	1.28155
Lead	2	17.8896 mg/kg	200 mg/kg	0.05	0.1	1.64485	1.28155
Manganese	2	55.7772 mg/kg	1619.65 mg/kg	0.05	0.1	1.64485	1.28155
Mercury	2	0.114336 mg/kg	1.04361 mg/kg	0.05	0.1	1.64485	1.28155
Methylene chloride	2	0.00491894 mg/kg	0.630571 mg/kg	0.05	0.1	1.64485	1.28155
Nickel	2	2.08703 mg/kg	416.052 mg/kg	0.05	0.1	1.64485	1.28155
Phenanthrene	2	0.340649 mg/kg	852.601 mg/kg	0.05	0.1	1.64485	1.28155
Pyrene	2	0.280759 mg/kg	848.807 mg/kg	0.05	0.1	1.64485	1.28155
Toluene	2	0.000748414 mg/kg	260.585 mg/kg	0.05	0.1	1.64485	1.28155
Vanadium	2	6.37936 mg/kg	145.507 mg/kg	0.05	0.1	1.64485	1.28155
Xylene (total)	2	0.00135816 mg/kg	107.24 mg/kg	0.05	0.1	1.64485	1.28155
Zinc	2	46.5764 mg/kg	4960.74 mg/kg	0.05	0.1	1.64485	1.28155

[a] This value is automatically calculated by VSP based upon the user defined value of α.
[b] This value is automatically calculated by VSP based upon the user defined value of β.

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000) for Benzo(a)pyrene, the driving analyte. It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true mean values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at 1-α on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at 1-α. If any of the inputs change, the number of samples that result in the correct curve changes.



Statistical Assumptions
The assumptions associated with the formulas for computing the number of samples are:
1. the sample mean is normally distributed (this happens if the data are roughly symmetric or the sample size is more than 30; for extremely skewed data sets, additional samples may be required for the sample mean to be normally distributed),
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected randomly.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the sample locations were selected using a random process.

Sensitivity Analysis
The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that μ > action level and alpha (%), probability of mistakenly concluding that μ < action level. The following table shows the results of this analysis.

Number of Samples							
AL=9921.47		α=5		α=10		α=15	
		s=93.1528	s=46.5764	s=93.1528	s=46.5764	s=93.1528	s=46.5764
LBGR=90	β=5	43094496798	10773624201	34101715468	8525428868	28628191883	7157047972
	β=10	34101715469	8525428869	26160104311	6540026079	21395800251	5348950063
	β=15	28628191884	7157047972	21395800251	5348950064	17110003237	4277500810
LBGR=80	β=5	10773624201	2693406052	8525428868	2131357218	7157047972	1789261994
	β=10	8525428869	2131357219	6540026079	1635006521	5348950063	1337237517
	β=15	7157047972	1789261995	5348950064	1337237517	4277500810	1069375203
LBGR=70	β=5	4788277424	1197069357	3789079498	947269875	3180910210	795227553

	β=10	3789079498	947269876	2906678258	726669565	2377311140	594327786
	β=15	3180910211	795227554	2377311140	594327786	1901111472	475277869

s = Standard Deviation
LBGR = Lower Bound of Gray Region (% of Action Level)
β = Beta (%), Probability of mistakenly concluding that μ > action level
α = Alpha (%), Probability of mistakenly concluding that μ < action level
AL = Action Level (Threshold)

Cost of Sampling
The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that are based on the number of samples collected and measured. Based on the numbers of samples determined above, the estimated total cost of sampling and analysis at this site is $2,544,500.00, which averages out to a per sample cost of $500.20. The following table summarizes the inputs and resulting cost estimates.

COST INFORMATION			
Cost Details	**Per Analysis**	**Per Sample**	**5087 Samples**
Field collection costs		$100.00	$508,700.00
Analytical costs	$400.00	$400.00	$2,034,800.00
Sum of Field & Analytical costs		**$500.00**	**$2,543,500.00**
Fixed planning and validation costs			$1,000.00
Total cost			**$2,544,500.00**

Data Analysis for New Location

SUMMARY STATISTICS for New Location								
n	5047							
Min	0							
Max	0							
Range	0							
Mean	0							
Median	0							
Variance	0							
StdDev	0							
Std Error	0							
Skewness	-1.#IND							
Interquartile Range	0							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0	0	0	0	0	0	0	0	0

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any

values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for New Location			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	-1.#IO	4.411	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Lilliefors test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Lilliefors Test Statistic	0
Lilliefors 5% Critical Value	0.01247

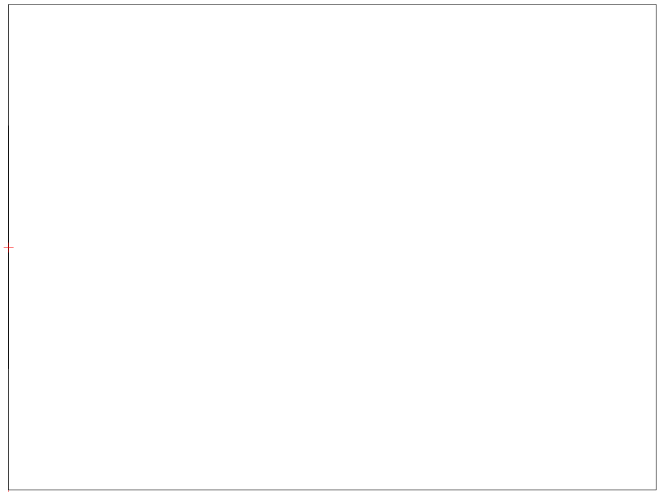
The calculated Lilliefors test statistic is less than the 5% Lilliefors critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do appear to follow a normal distribution at the 5% level of significance.

Data Plots for New Location
Graphical displays of the data are shown below.

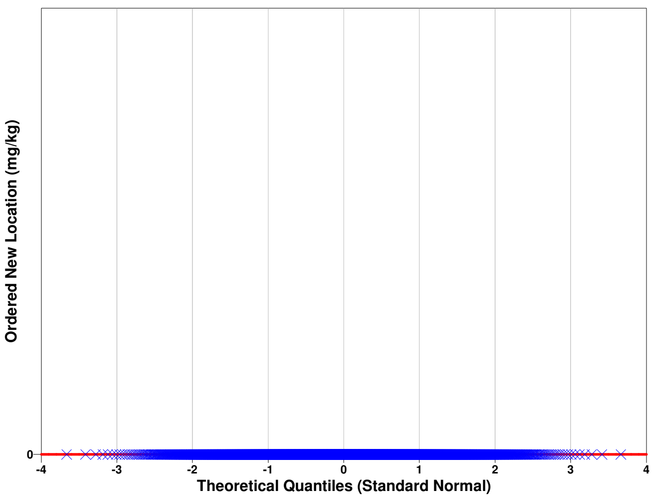
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.



New Location (mg/kg)



For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for New Location

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Lilliefors test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Lilliefors Test Statistic	0
Lilliefors 5% Critical Value	0.01247

The calculated Lilliefors test statistic is less than the 5% Lilliefors critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0

95% Non-Parametric (Chebyshev) UCL	0

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=5047 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=5046 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.#IND	1.6452	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Data Analysis for 1_2_4-Trimethylbenzene
The following data points were entered by the user for analysis.

1_2_4-Trimethylbenzene (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0006	0.0006	0.0006	0.0006	0.0006	0.00065	0.00065	0.00065	0.00065	0.00065
10	0.00065	0.00065	0.00065	0.00065	0.00065	0.00065	0.00065	0.000675	0.0007	0.0007
20	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.00075
30	0.00075	0.0008	0.00095	0.0015	0.0015	0.0015	0.0019	0.00195	0.002	0.0025
40	0.0032									

SUMMARY STATISTICS for 1_2_4-Trimethylbenzene	
n	41
Min	0.0006
Max	0.0032
Range	0.0026
Mean	0.00093841
Median	0.0007
Variance	3.4825e-007
StdDev	0.00059013
Std Error	9.2163e-005

Skewness				2.3483				
Interquartile Range				0.000125				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0006	0.0006	0.0006	0.00065	0.0007	0.000775	0.00194	0.00245	0.0032

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for 1_2_4-Trimethylbenzene			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.832	3.05	Yes

The test statistic 3.832 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for 1_2_4-Trimethylbenzene	
1	0.0032

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5935
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

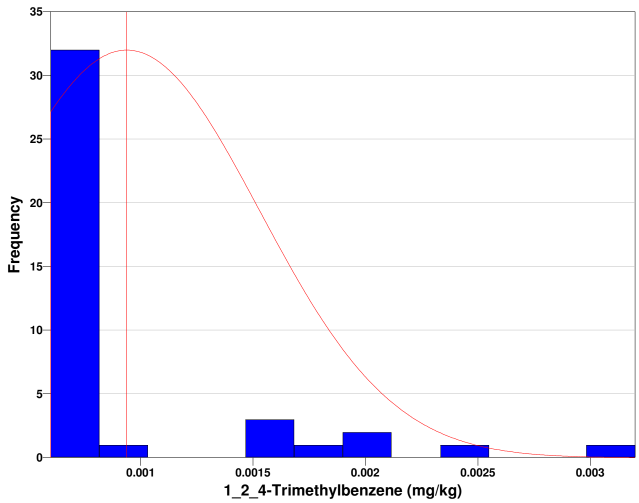
Data Plots for 1_2_4-Trimethylbenzene
Graphical displays of the data are shown below.

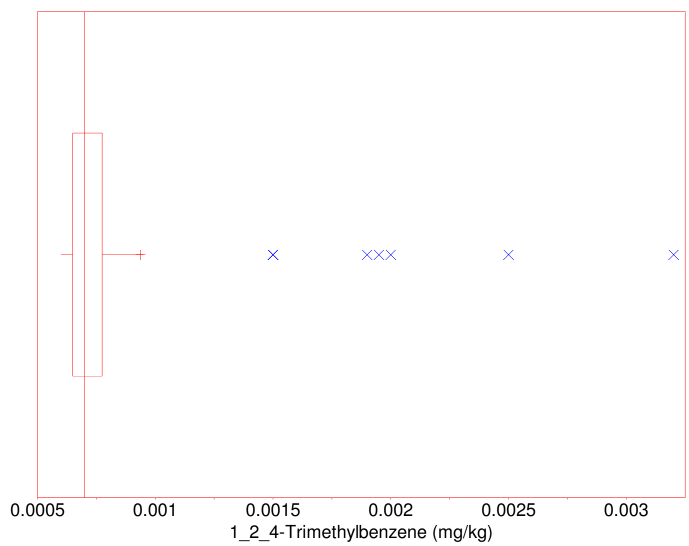
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

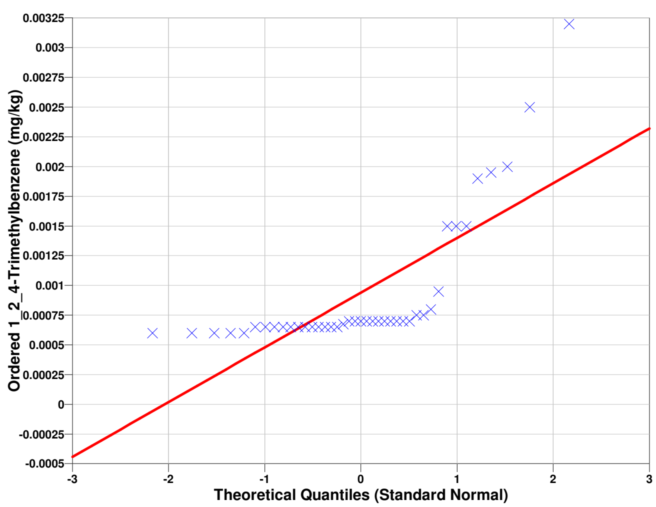
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles,

respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for 1_2_4-Trimethylbenzene
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5943

Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.001094
95% Non-Parametric (Chebyshev) UCL	0.00134

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.00134) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-5.6578e+005	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Acetone
The following data points were entered by the user for analysis.

Acetone (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00385	0.0039	0.00395	0.00405	0.00405	0.0041	0.0041	0.0041	0.00415	0.00418

10	0.0042	0.00423	0.00425	0.00425	0.00435	0.00435	0.00438	0.00445	0.00445	0.0045
20	0.0045	0.0045	0.0045	0.0045	0.0045	0.00455	0.00455	0.00455	0.0046	0.0046
30	0.0046	0.00475	0.005	0.005	0.0065	0.0099	0.0099	0.0121	0.0125	0.0401
40	0.0963									

SUMMARY STATISTICS for Acetone								
n	41							
Min	0.00385							
Max	0.0963							
Range	0.09245							
Mean	0.0081912							
Median	0.0045							
Variance	0.00023308							
StdDev	0.015267							
Std Error	0.0023843							
Skewness	5.2787							
Interquartile Range	0.000485							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00385	0.003905	0.00405	0.00419	0.0045	0.004675	0.01166	0.03734	0.0963

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Acetone			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.771	3.05	Yes

The test statistic 5.771 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Acetone	
1	0.0963

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)

Shapiro-Wilk Test Statistic	0.3513
Shapiro-Wilk 5% Critical Value	0.94

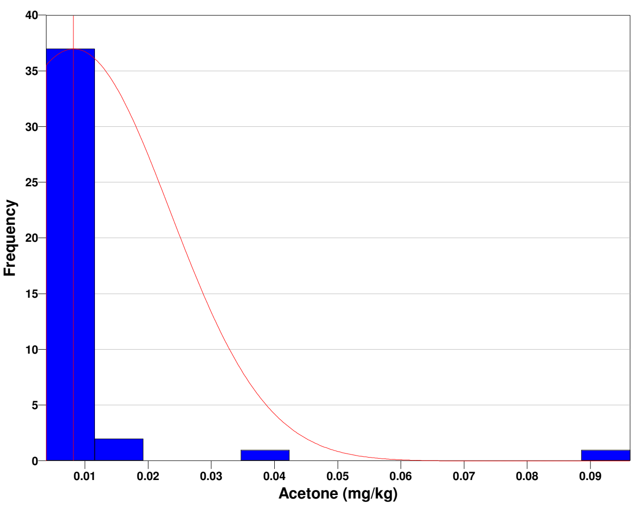
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

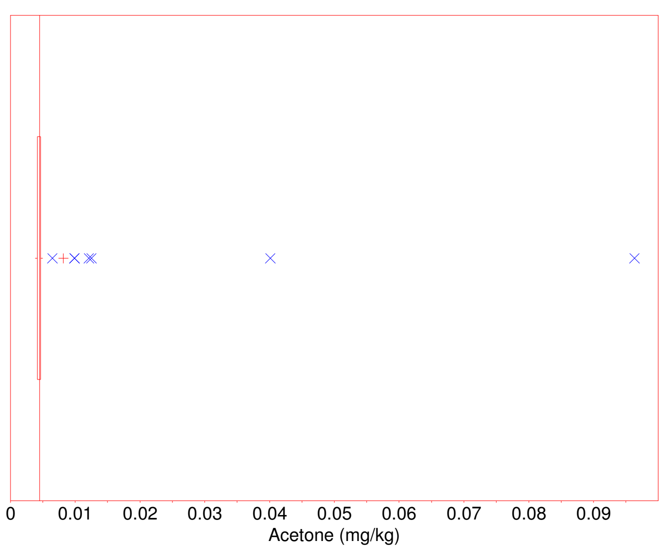
Data Plots for Acetone
Graphical displays of the data are shown below.

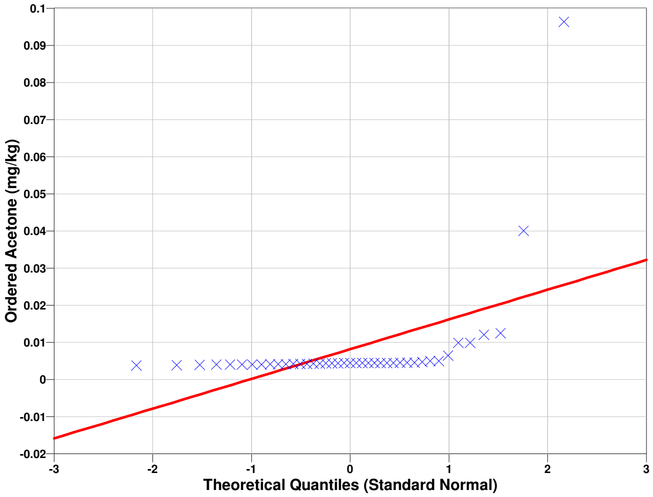
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Acetone
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.2997
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.01221
95% Non-Parametric (Chebyshev) UCL	0.01858

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.01858) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-2.2721e+006	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Aluminum
The following data points were entered by the user for analysis.

Aluminum (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	609	640	786	820	1110	1250	1440	1670	2110	2540
10	2550	2590	2600	2710	2900	3010	3030	3550	3680	4380
20	4470	4570	4830	5020	5110	5130	5460	5510	5620	6190
30	7070	7830	8090	9850	9900	1.22e+004	1.42e+004	1.43e+004	1.44e+004	1.57e+004
40	2.54e+004									

SUMMARY STATISTICS for Aluminum	
n	41
Min	609
Max	25400
Range	24791
Mean	5727.4
Median	4470
Variance	2.6816e+007
StdDev	5178.4
Std Error	808.73
Skewness	1.8561
Interquartile Range	4905

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
609	654.6	878	2545	4470	7450	1.428e+004	1.557e+004	2.54e+004

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Aluminum			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.799	3.05	Yes

The test statistic 3.799 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Aluminum	
1	25400

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8541
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

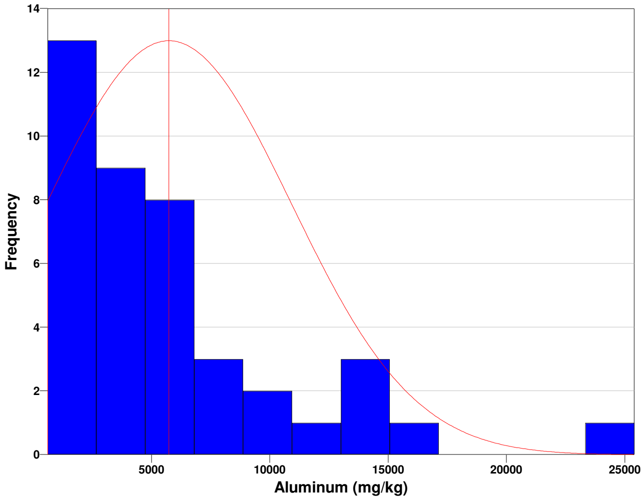
Data Plots for Aluminum
Graphical displays of the data are shown below.

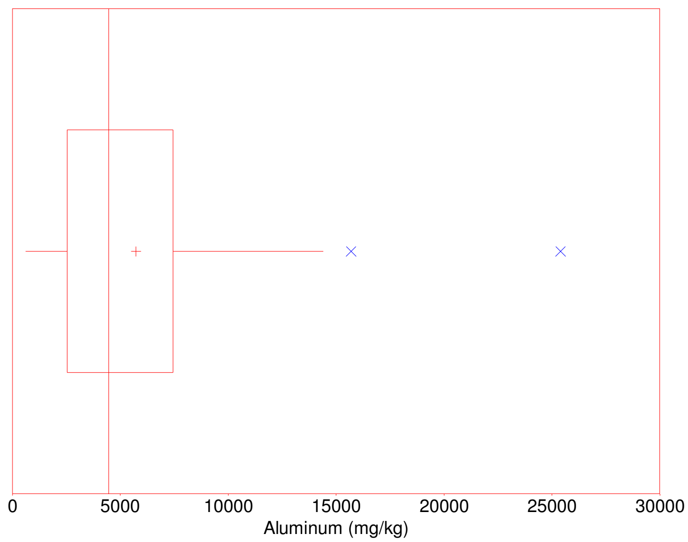
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

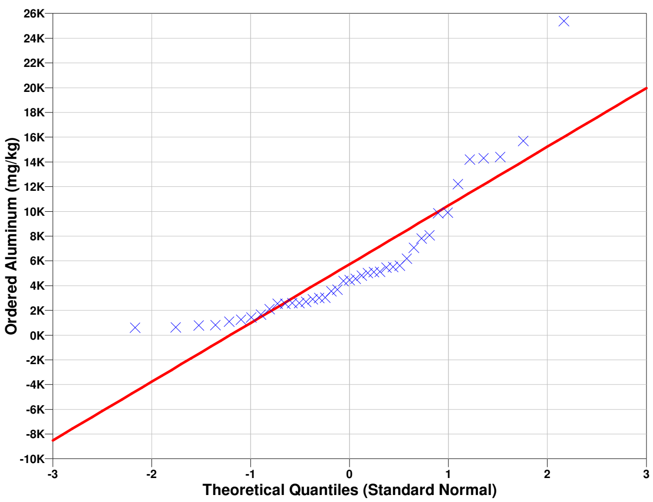
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the

Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Aluminum
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8146
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	7089
95% Non-Parametric (Chebyshev) UCL	9253

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (9253) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-0.98144	1.6839	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
30	26	Reject

Data Analysis for Arsenic
The following data points were entered by the user for analysis.

Arsenic (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.09	0.11	0.12	0.22	0.23	0.278	0.29	0.305	0.31	0.35
10	0.51	0.53	0.57	0.58	0.66	0.72	0.83	0.86	0.93	1.04
20	1.1	1.2	1.3	1.3	1.4	1.45	1.5	1.6	1.7	1.8
30	2	2	2	2.2	2.4	2.5	2.6	2.6	2.8	3
40	3.1									

SUMMARY STATISTICS for Arsenic	
n	41

Min				0.09				
Max				3.1				
Range				3.01				
Mean				1.2459				
Median				1.1				
Variance				0.80868				
StdDev				0.89926				
Std Error				0.14044				
Skewness				0.50174				
Interquartile Range				1.57				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.09	0.111	0.222	0.43	1.1	2	2.6	2.98	3.1

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Arsenic			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.062	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.92
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

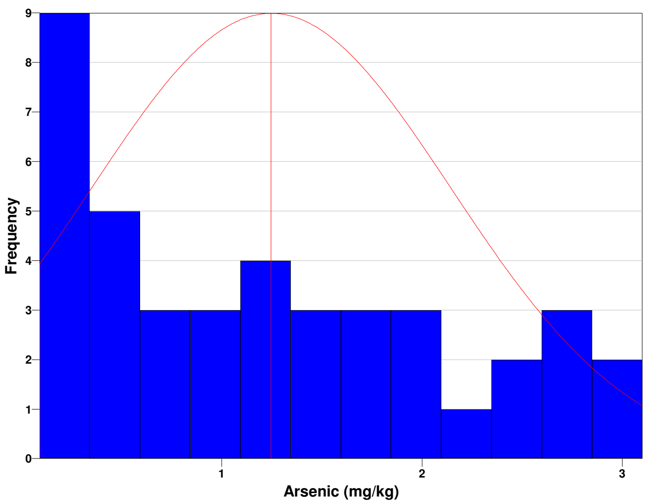
Data Plots for Arsenic
Graphical displays of the data are shown below.

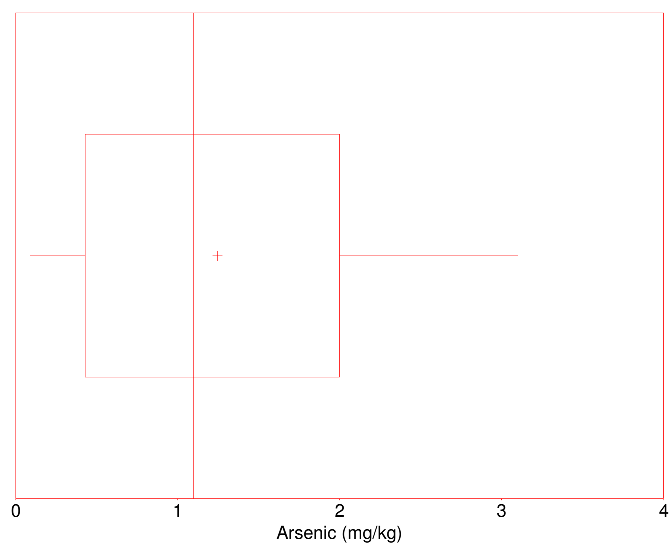
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each

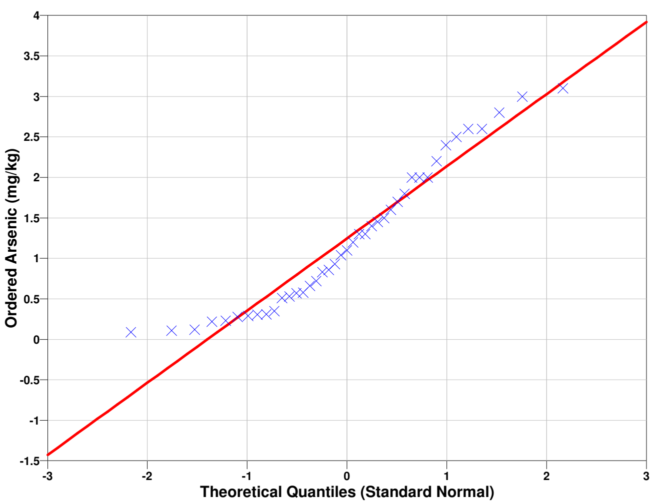
bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Arsenic
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.918
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	1.482
95% Non-Parametric (Chebyshev) UCL	1.858

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (1.858) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
6.0972	1.6839	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
10	26	Cannot Reject
Note: There may not be enough data to reject the null hypothesis (and conclude site is clean) with 95% confidence using the MARSSIM sign test.		

Data Analysis for Barium
The following data points were entered by the user for analysis.

Barium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	6.25	13.7	13.9	19	23.4	25.9	26.9	28.4	30.2	31.4
10	36	36.1	36.7	39.9	41.4	53.5	60.3	61.5	61.7	63.5
20	64.5	66.6	67.1	69.1	72.2	86.4	88.9	91.8	94	98.6
30	103	104	109	160	162	165	177	200	381	944
40	1250									

SUMMARY STATISTICS for Barium								
n	41							
Min	6.25							
Max	1250							
Range	1243.8							
Mean	128.39							
Median	64.5							
Variance	55073							
StdDev	234.68							
Std Error	36.65							
Skewness	3.968							
Interquartile Range	69.8							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
6.25	13.72	19.88	33.7	64.5	103.5	195.4	887.7	1250

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Barium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.779	3.05	Yes

The test statistic 4.779 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Barium

1	1250

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.4913
Shapiro-Wilk 5% Critical Value	0.94

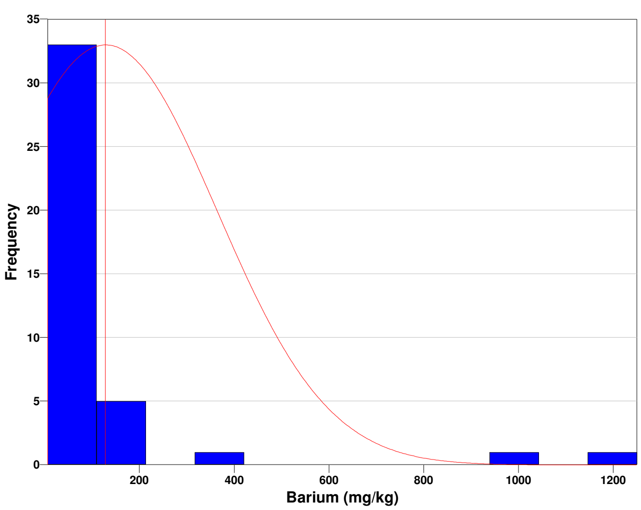
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

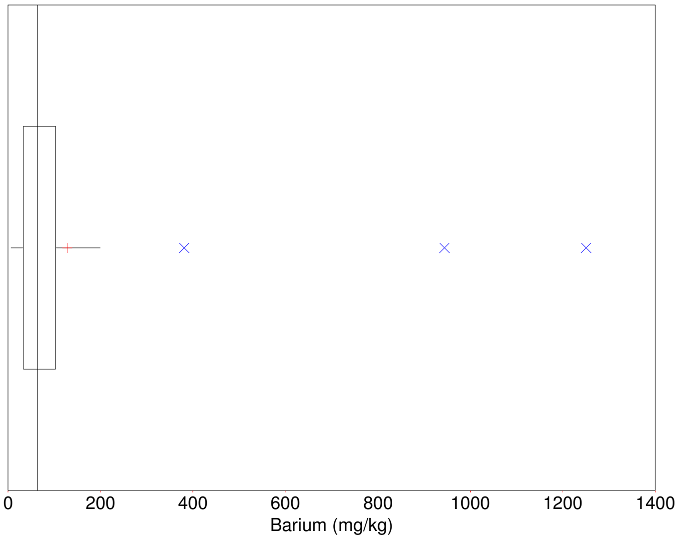
Data Plots for Barium
Graphical displays of the data are shown below.

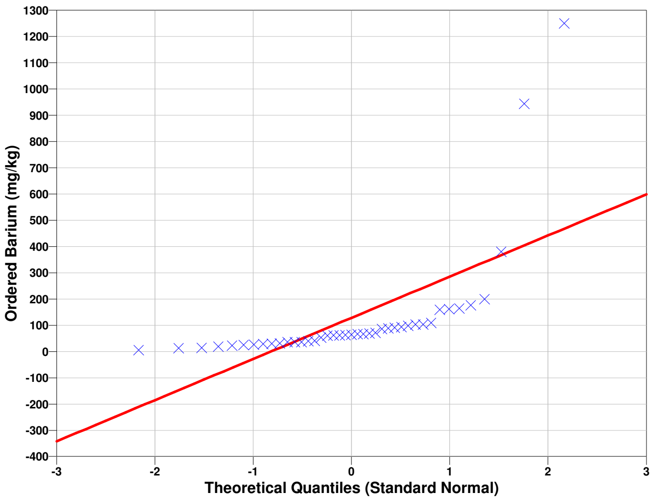
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Barium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.4558
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	190.1

95% Non-Parametric (Chebyshev) UCL	288.1

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (288.1) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-210.42	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Benzo(a)anthracene
The following data points were entered by the user for analysis.

Benzo(a)anthracene (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.034	0.035	0.036	0.036	0.036	0.0365	0.037	0.037	0.037	0.037
10	0.0375	0.0375	0.0378	0.038	0.038	0.038	0.0385	0.0388	0.039	0.039
20	0.0395	0.04	0.04	0.04	0.0405	0.041	0.041	0.042	0.042	0.0425
30	0.055	0.121	0.142	0.355	0.36	0.37	0.39	0.398	0.648	0.72
40	3.97									

SUMMARY STATISTICS for Benzo(a)anthracene	
n	41
Min	0.034
Max	3.97

Range				3.936				
Mean				0.21173				
Median				0.0395				
Variance				0.39116				
StdDev				0.62543				
Std Error				0.097675				
Skewness				5.711				
Interquartile Range				0.05075				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.034	0.0351	0.036	0.03725	0.0395	0.088	0.3964	0.7128	3.97

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Benzo(a)anthracene			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	6.009	3.05	Yes

The test statistic 6.009 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Benzo(a)anthracene	
1	3.97

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5398
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

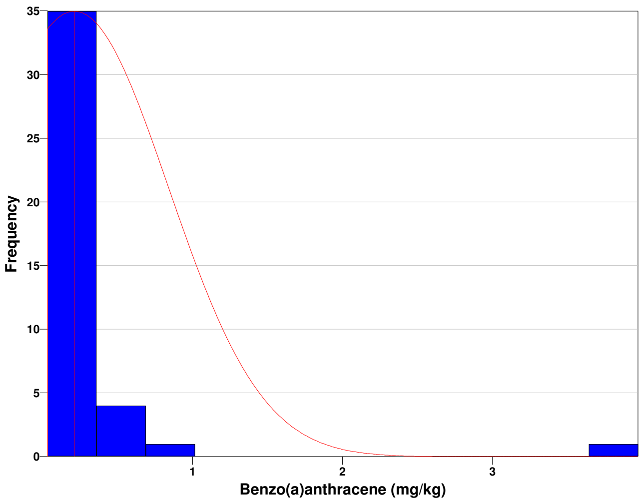
Data Plots for Benzo(a)anthracene
Graphical displays of the data are shown below.

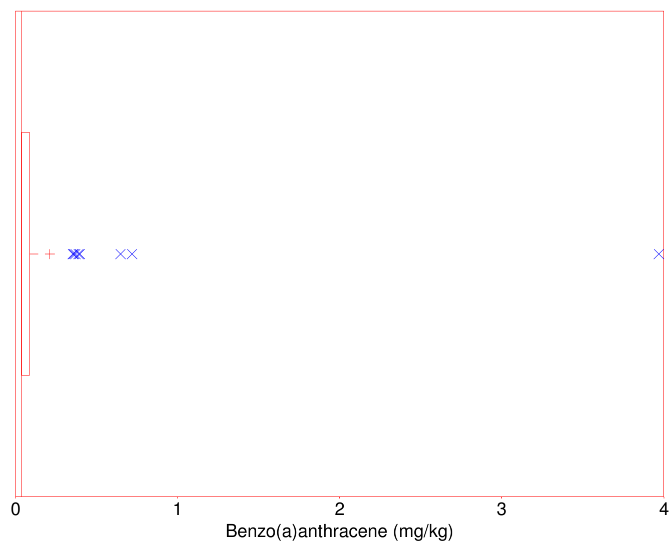
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

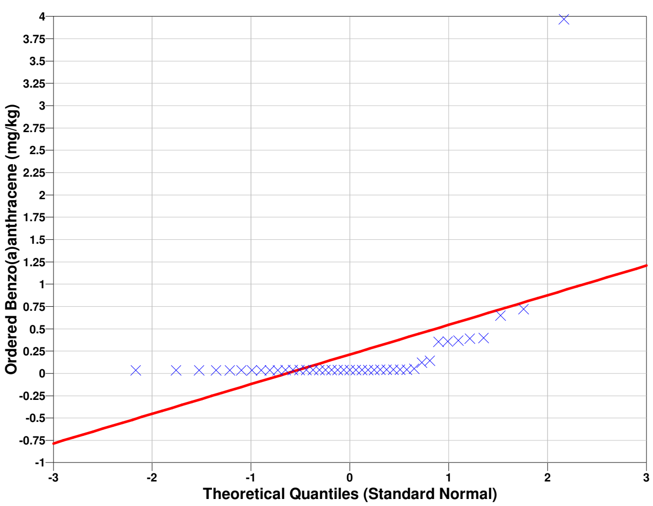
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Benzo(a)anthracene
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.3091
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.3762
95% Non-Parametric (Chebyshev) UCL	0.6375

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.6375) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
0.65641	1.6839	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
33	26	Reject

Data Analysis for Benzo(a)pyrene
The following data points were entered by the user for analysis.

Benzo(a)pyrene (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.03	0.031	0.0315	0.0315	0.0315	0.032	0.0325	0.0325	0.0325	0.0328
10	0.0328	0.033	0.033	0.0333	0.0335	0.0335	0.0335	0.0338	0.034	0.0345
20	0.035	0.035	0.035	0.035	0.0355	0.036	0.036	0.037	0.037	0.0375
30	0.0485	0.07	0.0985	0.172	0.31	0.315	0.325	0.34	0.348	0.766
40	0.775									

SUMMARY STATISTICS for Benzo(a)pyrene								
n	41							
Min	0.03							
Max	0.775							
Range	0.745							
Mean	0.1117							
Median	0.035							
Variance	0.032356							
StdDev	0.17988							
Std Error	0.028092							
Skewness	2.7482							
Interquartile Range	0.02645							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.03	0.03105	0.0315	0.0328	0.035	0.05925	0.337	0.7242	0.775

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Benzo(a)pyrene			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.688	3.05	Yes

The test statistic 3.688 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Benzo(a)pyrene

1	0.775

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5037
Shapiro-Wilk 5% Critical Value	0.94

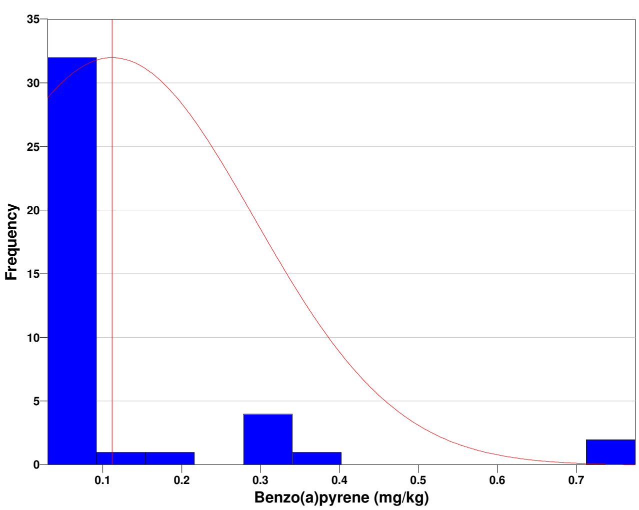
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

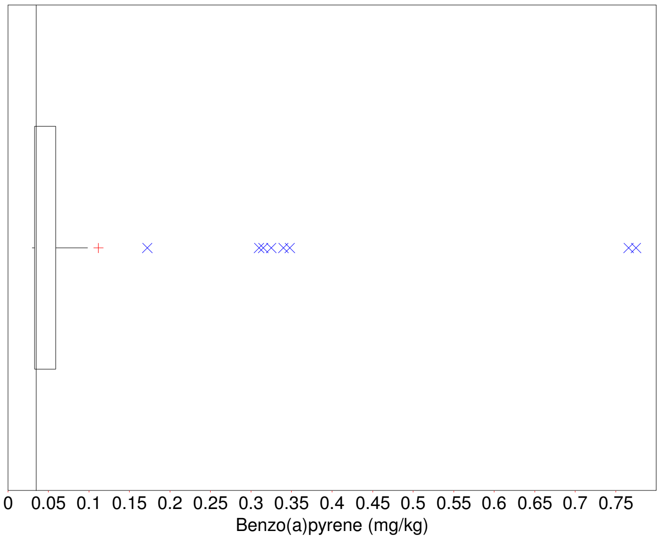
Data Plots for Benzo(a)pyrene
Graphical displays of the data are shown below.

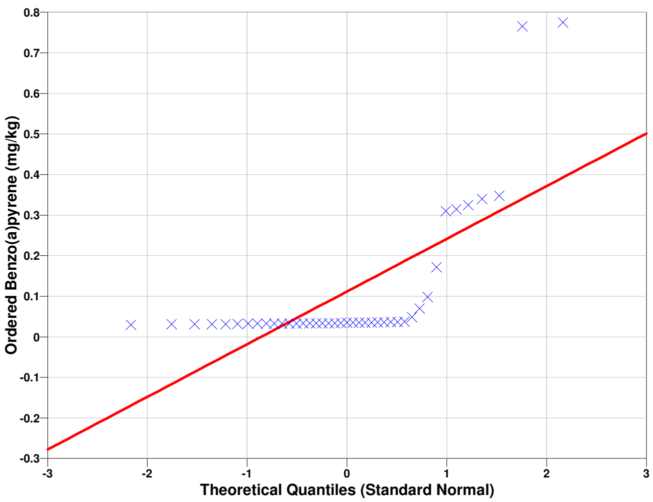
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Benzo(a)pyrene
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5102
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.159

95% Non-Parametric (Chebyshev) UCL	0.2342

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.2342) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
3.4507	1.6839	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
0	26	Cannot Reject
Note: There may not be enough data to reject the null hypothesis (and conclude site is clean) with 95% confidence using the MARSSIM sign test.		

Data Analysis for Benzo(b)fluoranthene
The following data points were entered by the user for analysis.

Benzo(b)fluoranthene (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0385	0.04	0.041	0.041	0.041	0.0415	0.042	0.042	0.042	0.04225
10	0.0425	0.0425	0.04275	0.043	0.043	0.0435	0.0435	0.04375	0.044	0.0445
20	0.045	0.045	0.04525	0.0455	0.046	0.0465	0.0465	0.048	0.048	0.0485
30	0.065	0.135	0.181	0.218	0.405	0.41	0.42	0.44	0.45	0.465
40	1.03									

SUMMARY STATISTICS for Benzo(b)fluoranthene

n	41
Min	0.0385
Max	1.03
Range	0.9915
Mean	0.13482
Median	0.045
Variance	0.039913
StdDev	0.19978
Std Error	0.031201
Skewness	2.816
Interquartile Range	0.057625

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0385	0.0401	0.041	0.04238	0.045	0.1	0.436	0.4635	1.03

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Benzo(b)fluoranthene			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.481	3.05	Yes

The test statistic 4.481 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Benzo(b)fluoranthene	
1	1.03

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.542
Shapiro-Wilk 5% Critical Value	0.94

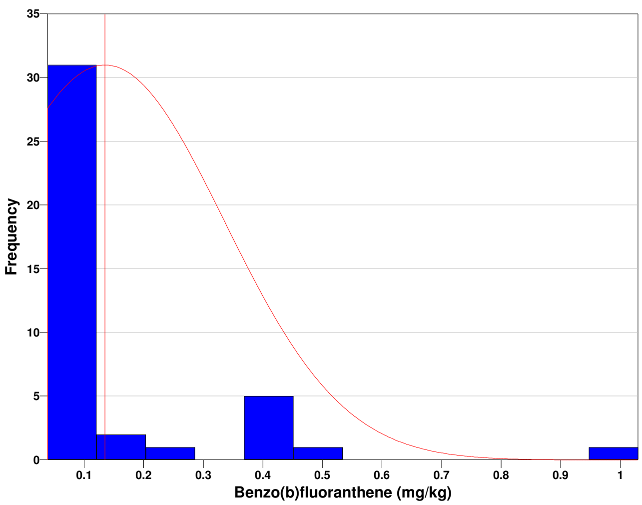
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

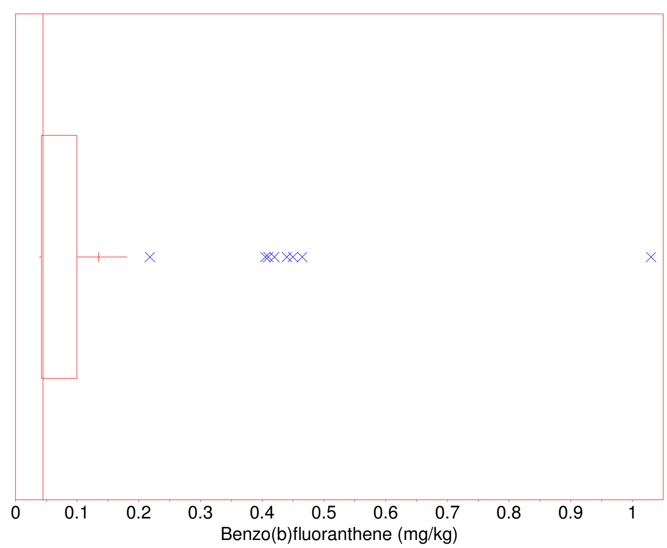
Data Plots for Benzo(b)fluoranthene
Graphical displays of the data are shown below.

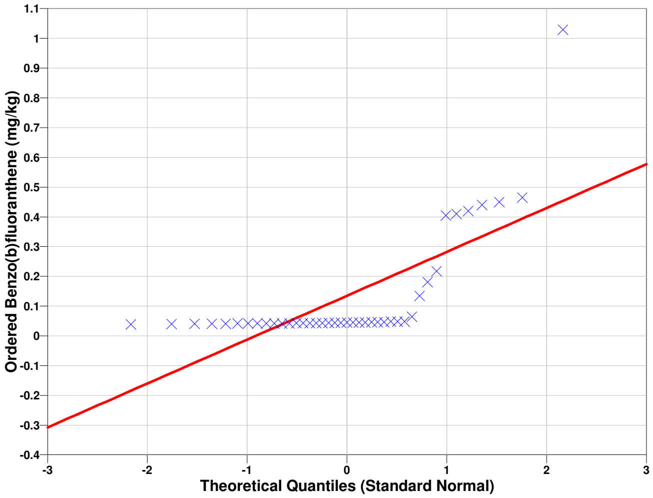
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Benzo(b)fluoranthene
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5433
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.1874
95% Non-Parametric (Chebyshev) UCL	0.2708

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.2708) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-0.4097	1.6839	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
32	26	Reject

Data Analysis for Beryllium
The following data points were entered by the user for analysis.

Beryllium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0105	0.011	0.012	0.023	0.041	0.049	0.056	0.056	0.0706	0.074
10	0.075	0.078	0.087	0.092	0.094	0.1	0.11	0.12	0.13	0.13
20	0.14	0.15	0.16	0.19	0.2	0.2	0.2	0.22	0.22	0.23
30	0.24	0.27	0.31	0.34	0.37	0.38	0.46	0.49	0.52	0.52
40	0.89									

SUMMARY STATISTICS for Beryllium								
n	41							
Min	0.0105							
Max	0.89							
Range	0.8795							
Mean	0.19803							
Median	0.14							
Variance	0.03256							
StdDev	0.18044							
Std Error	0.028181							
Skewness	1.8101							
Interquartile Range	0.1805							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0105	0.0111	0.0266	0.0745	0.14	0.255	0.484	0.52	0.89

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Beryllium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.835	3.05	Yes

The test statistic 3.835 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Beryllium	
1	0.89

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8787
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

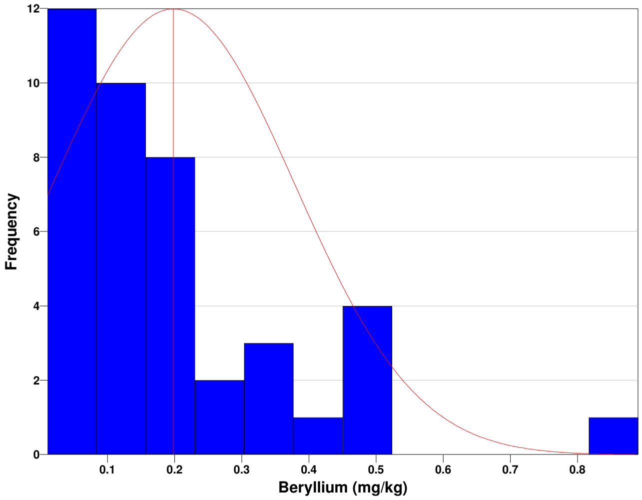
Data Plots for Beryllium
Graphical displays of the data are shown below.

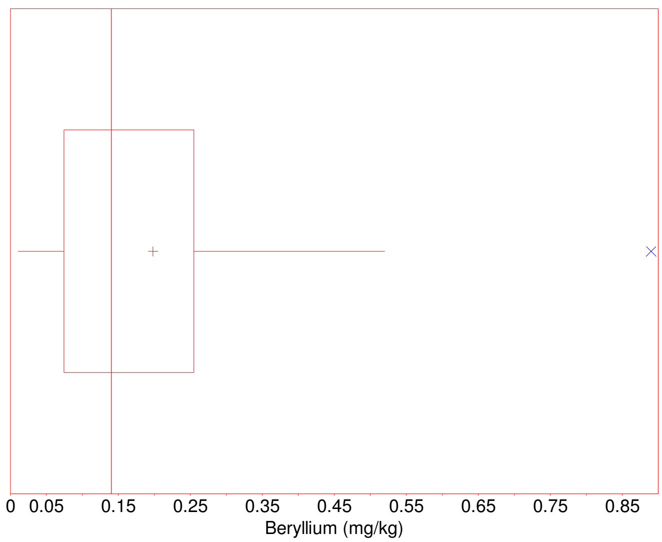
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

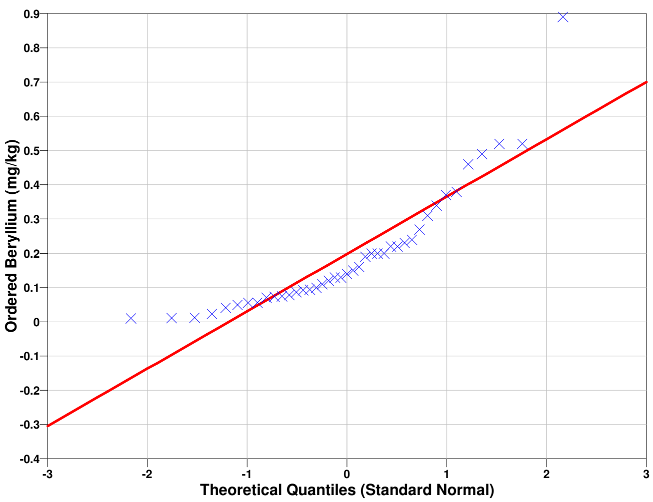
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the

Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Beryllium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8343
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.2455
95% Non-Parametric (Chebyshev) UCL	0.3209

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.3209) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1326	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for bis(2-Ethylhexyl)phthalate
The following data points were entered by the user for analysis.

bis(2-Ethylhexyl)phthalate (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0455	0.047	0.0475	0.0485	0.0485	0.0485	0.0485	0.0485	0.049	0.0495
10	0.0495	0.0495	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20	0.05	0.054	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.075
30	0.117	0.15	0.269	0.37	0.384	0.475	0.485	0.495	0.5	0.525
40	0.55									

SUMMARY STATISTICS for bis(2-Ethylhexyl)phthalate	
n	41

Min	0.0455
Max	0.55
Range	0.5045
Mean	0.14302
Median	0.05
Variance	0.029212
StdDev	0.17091
Std Error	0.026692
Skewness	1.5437
Interquartile Range	0.084

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0455	0.04705	0.0485	0.0495	0.05	0.1335	0.493	0.5225	0.55

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for bis(2-Ethylhexyl)phthalate			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.381	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5668
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

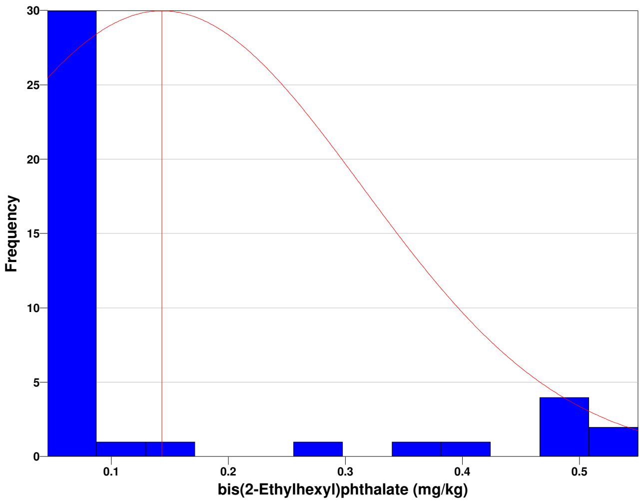
Data Plots for bis(2-Ethylhexyl)phthalate
Graphical displays of the data are shown below.

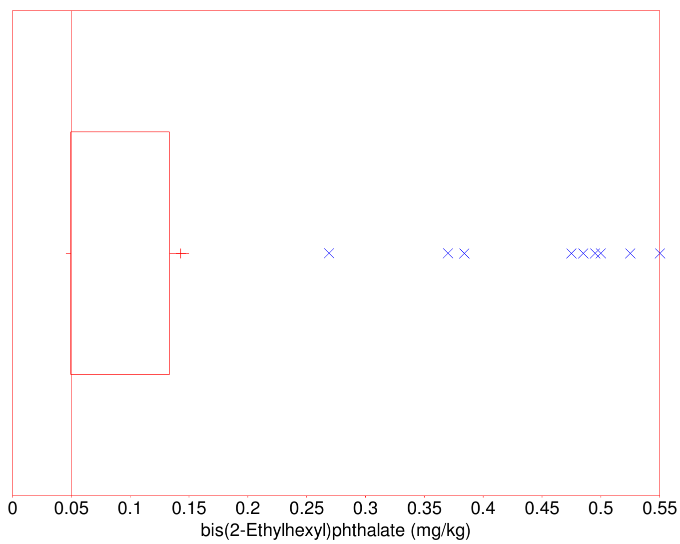
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each

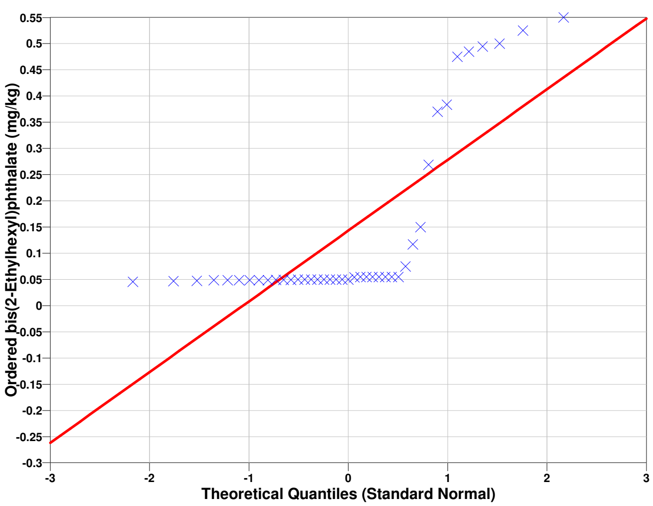
bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for bis(2-Ethylhexyl)phthalate
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5871
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.188
95% Non-Parametric (Chebyshev) UCL	0.2594

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.2594) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1296.2	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Cadmium
The following data points were entered by the user for analysis.

Cadmium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0405	0.0418	0.043	0.045	0.046	0.047	0.0485	0.049	0.0495	0.05
10	0.05	0.0525	0.0525	0.0525	0.055	0.055	0.055	0.055	0.055	0.055
20	0.055	0.055	0.055	0.0575	0.0575	0.0575	0.06	0.06	0.06	0.06
30	0.06	0.065	0.065	0.07	0.12	0.14	0.17	0.19	0.23	0.56
40	1.1									

SUMMARY STATISTICS for Cadmium	
n	41
Min	0.0405
Max	1.1
Range	1.0595
Mean	0.10598
Median	0.055
Variance	0.032888
StdDev	0.18135
Std Error	0.028322
Skewness	4.7306
Interquartile Range	0.0125

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0405	0.04192	0.0452	0.05	0.055	0.0625	0.186	0.527	1.1

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Cadmium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.481	3.05	Yes

The test statistic 5.481 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Cadmium

1	1.1

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.4281
Shapiro-Wilk 5% Critical Value	0.94

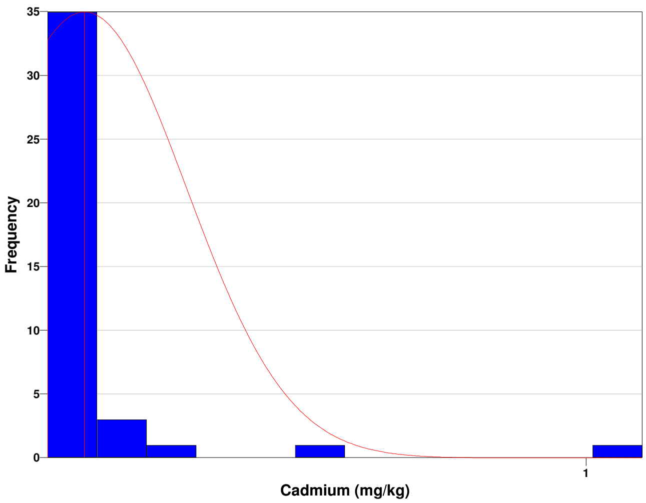
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

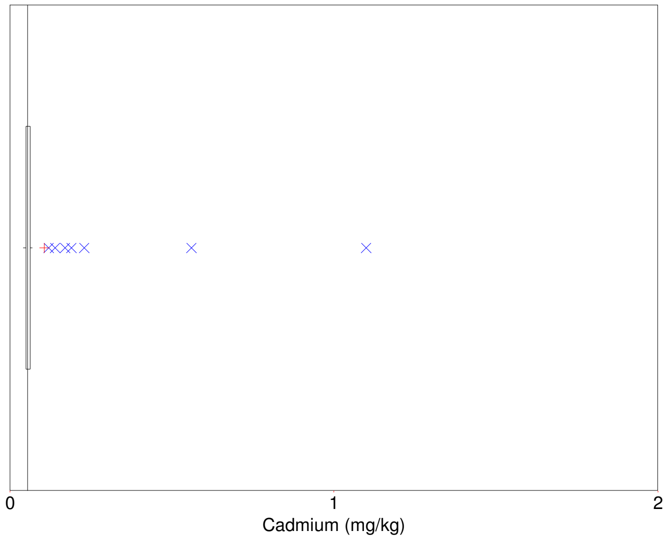
Data Plots for Cadmium
Graphical displays of the data are shown below.

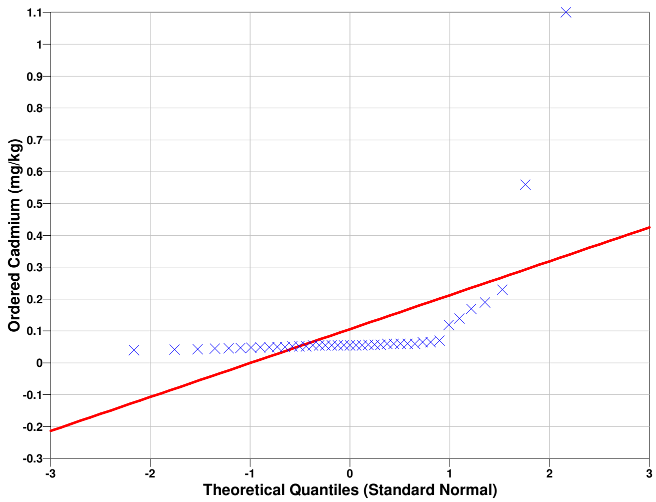
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Cadmium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.3646
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.1537

95% Non-Parametric (Chebyshev) UCL	0.2294

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.2294) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1372.7	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Chromium
The following data points were entered by the user for analysis.

Chromium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.505	0.77	0.9	0.92	1.1	1.4	1.45	1.6	1.71	2
10	2.3	2.8	2.8	2.9	3.6	3.6	3.7	3.8	3.9	4
20	4	4.2	4.5	4.5	4.9	5.05	5.1	5.15	6.4	6.7
30	6.9	7.4	7.8	8.3	8.9	9	9.6	10.4	11.3	13.3
40	14.9									

SUMMARY STATISTICS for Chromium	
n	41
Min	0.505
Max	14.9

Range	14.395
Mean	4.977
Median	4
Variance	12.44
StdDev	3.527
Std Error	0.55082
Skewness	1.0011
Interquartile Range	5

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.505	0.783	0.956	2.15	4	7.15	10.24	13.1	14.9

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Chromium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.813	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9271
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

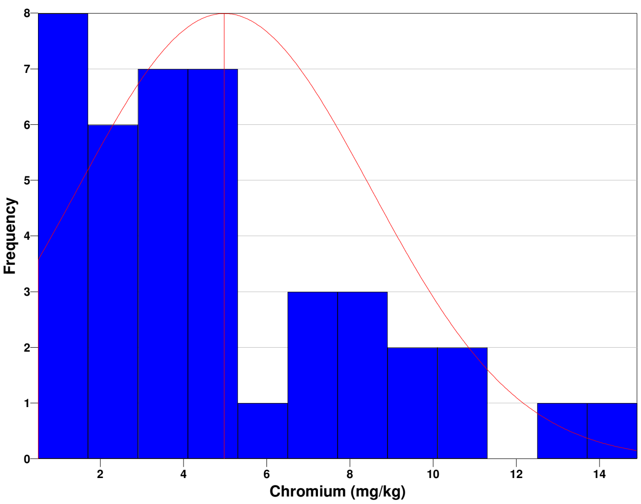
Data Plots for Chromium
Graphical displays of the data are shown below.

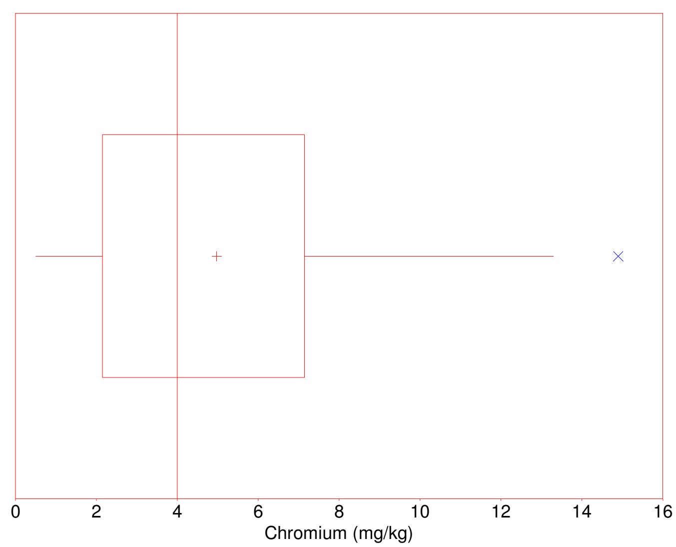
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally

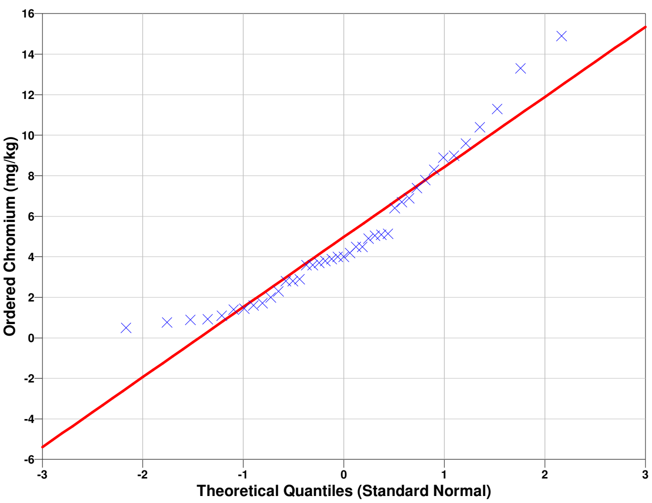
distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Chromium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was

conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9122
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	5.904
95% Non-Parametric (Chebyshev) UCL	7.378

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (7.378) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-373.44	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Chromium_ Hexavalent
The following data points were entered by the user for analysis.

Chromium_ Hexavalent (mg/kg)

Rank	1	2	3	4	5	6	7	8	9	10
0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.55	0.6
10	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.625	0.65	0.65
20	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
30	0.7	0.7	0.7	0.9	1.2	1.3	1.3	1.4	1.8	1.9
40	3.1									

SUMMARY STATISTICS for Chromium_ Hexavalent								
n	41							
Min	0.5							
Max	3.1							
Range	2.6							
Mean	0.79939							
Median	0.65							
Variance	0.24908							
StdDev	0.49908							
Std Error	0.077943							
Skewness	3.1085							
Interquartile Range	0.1							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.5	0.5	0.5	0.6	0.65	0.7	1.38	1.89	3.1

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Chromium_ Hexavalent			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.61	3.05	Yes

The test statistic 4.61 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Chromium_ Hexavalent	
1	3.1

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the

suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6385
Shapiro-Wilk 5% Critical Value	0.94

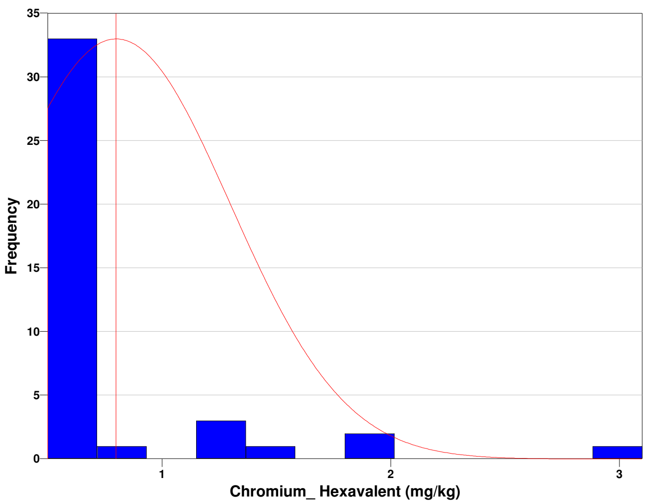
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

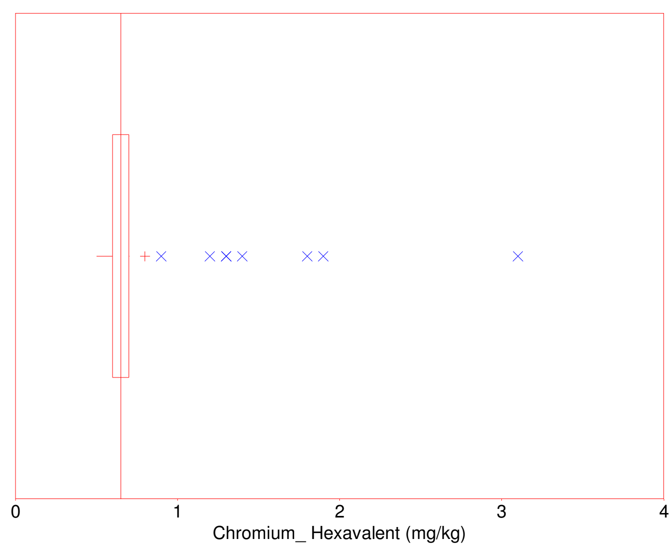
Data Plots for Chromium_ Hexavalent
Graphical displays of the data are shown below.

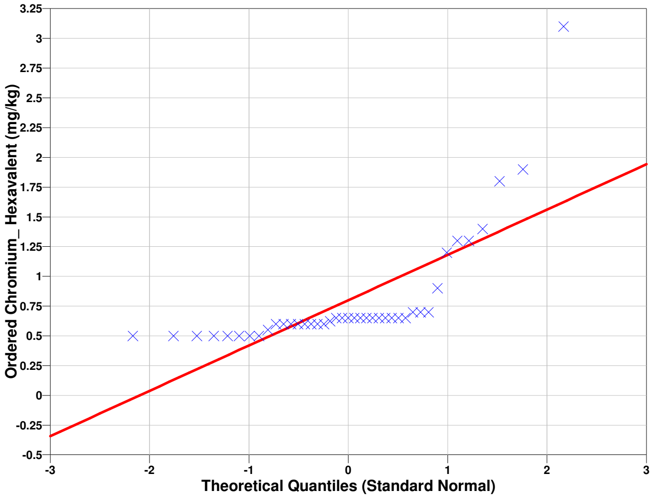
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Chromium_ Hexavalent
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5817
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.9306
95% Non-Parametric (Chebyshev) UCL	1.139

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (1.139) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-375.88	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Chrysene
The following data points were entered by the user for analysis.

Chrysene (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.03	0.031	0.032	0.032	0.032	0.032	0.0325	0.0325	0.0325	0.0328
10	0.0328	0.033	0.0333	0.0335	0.0335	0.0335	0.034	0.0343	0.0345	0.0345
20	0.035	0.035	0.0353	0.0353	0.0355	0.036	0.0365	0.037	0.037	0.0375
30	0.0485	0.163	0.164	0.315	0.32	0.325	0.34	0.35	0.773	9.61
40	41.2									

SUMMARY STATISTICS for Chrysene								
n	41							
Min	0.03							
Max	41.2							
Range	41.17							
Mean	1.3323							
Median	0.035							
Variance	42.956							
StdDev	6.5541							
Std Error	1.0236							
Skewness	5.9612							
Interquartile Range	0.07295							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.03	0.0311	0.032	0.0328	0.035	0.1058	0.348	8.726	41.2

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Chrysene			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	6.083	3.05	Yes

The test statistic 6.083 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Chrysene	
1	41.2

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.21
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

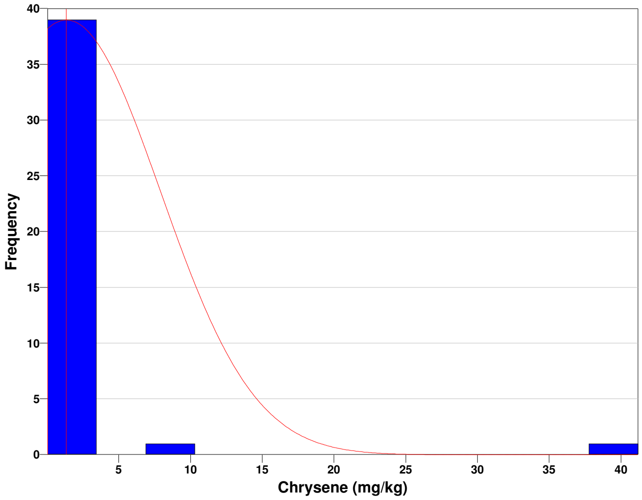
Data Plots for Chrysene
Graphical displays of the data are shown below.

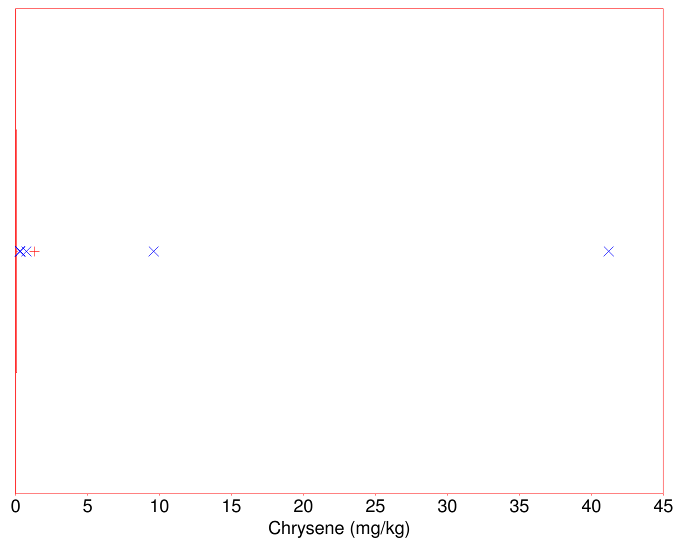
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

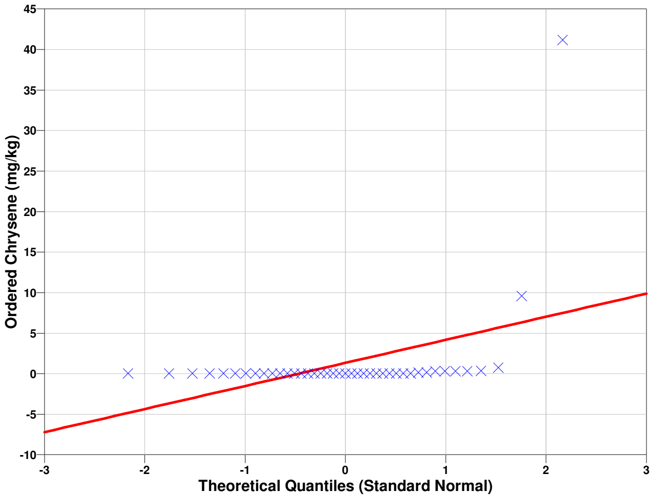
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the

Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Chrysene
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.2166
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	3.056
95% Non-Parametric (Chebyshev) UCL	5.794

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (5.794) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-13.12	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
40	26	Reject

Data Analysis for Cobalt
The following data points were entered by the user for analysis.

Cobalt (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.08	0.095	0.1	0.108	0.19	0.2	0.36	0.43	0.44	0.464
10	0.47	0.53	0.61	0.62	0.71	0.74	1	1.1	1.1	1.2
20	1.3	1.3	1.3	1.3	1.3	1.45	1.45	1.5	1.55	1.6
30	1.7	1.7	1.8	2.2	2.3	2.5	2.5	2.8	3	3.3
40	4.6									

SUMMARY STATISTICS for Cobalt	
n	41

Min	0.08
Max	4.6
Range	4.52
Mean	1.2926
Median	1.3
Variance	0.99774
StdDev	0.99887
Std Error	0.156
Skewness	1.1633
Interquartile Range	1.233

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.08	0.0955	0.1244	0.467	1.3	1.7	2.74	3.27	4.6

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Cobalt			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.311	3.05	Yes

The test statistic 3.311 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Cobalt	
1	4.6

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9312
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

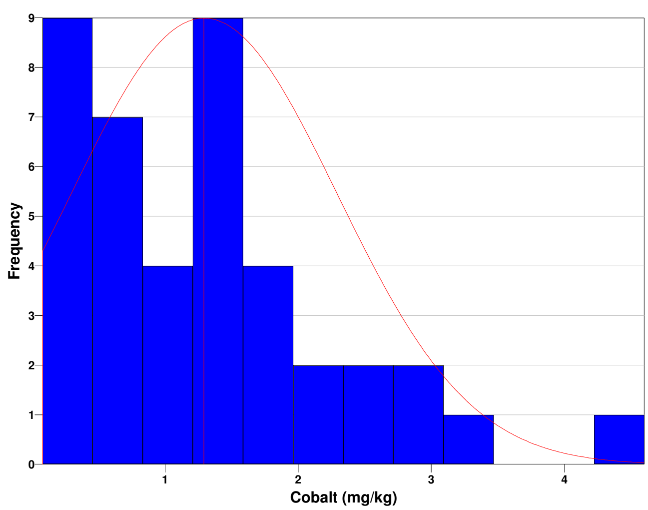
Data Plots for Cobalt

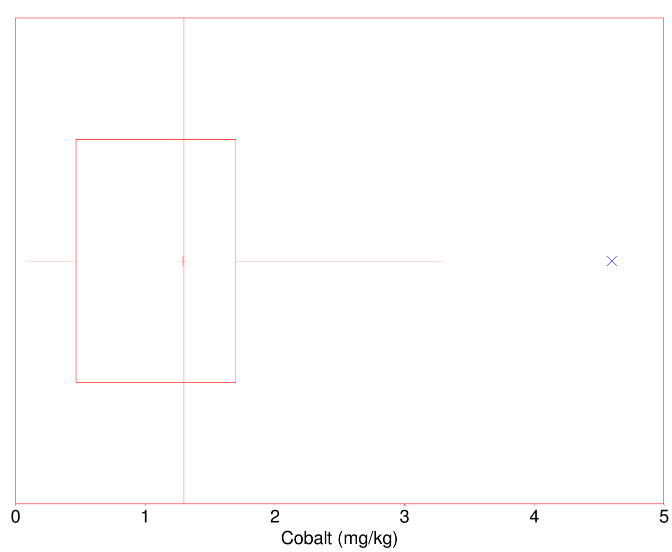
Graphical displays of the data are shown below.

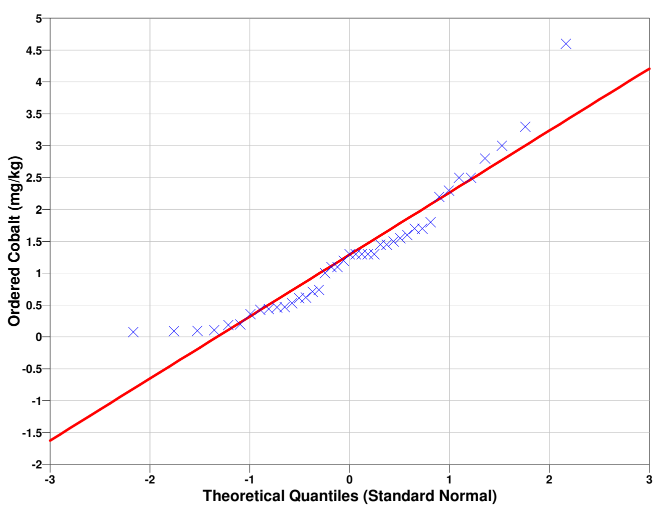
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Cobalt
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9087
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	1.555
95% Non-Parametric (Chebyshev) UCL	1.973

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (1.973) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-5779.6	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**

41	26	Reject

Data Analysis for Copper
The following data points were entered by the user for analysis.

Copper (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.685	0.86	0.93	0.93	0.95	0.99	1	1.01	1.1	1.4
10	1.7	2.2	2.4	2.5	2.5	2.7	2.7	3.1	3.2	3.25
20	3.3	3.3	3.4	3.55	3.6	3.6	3.7	4.2	4.5	4.7
30	4.7	4.8	5.1	5.2	5.7	6.9	8.1	9.6	10.3	10.7
40	23.5									

SUMMARY STATISTICS for Copper								
n	41							
Min	0.685							
Max	23.5							
Range	22.815							
Mean	4.1111							
Median	3.3							
Variance	16.062							
StdDev	4.0077							
Std Error	0.62589							
Skewness	3.1509							
Interquartile Range	3.2							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.685	0.867	0.934	1.55	3.3	4.75	9.3	10.66	23.5

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Copper			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.838	3.05	Yes

The test statistic 4.838 exceeded the corresponding critical value, therefore that test is significant and we conclude that the

most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Copper	
1	23.5

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8635
Shapiro-Wilk 5% Critical Value	0.94

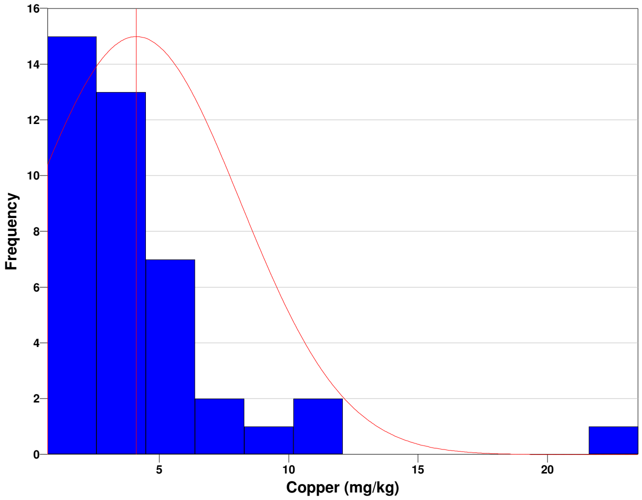
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

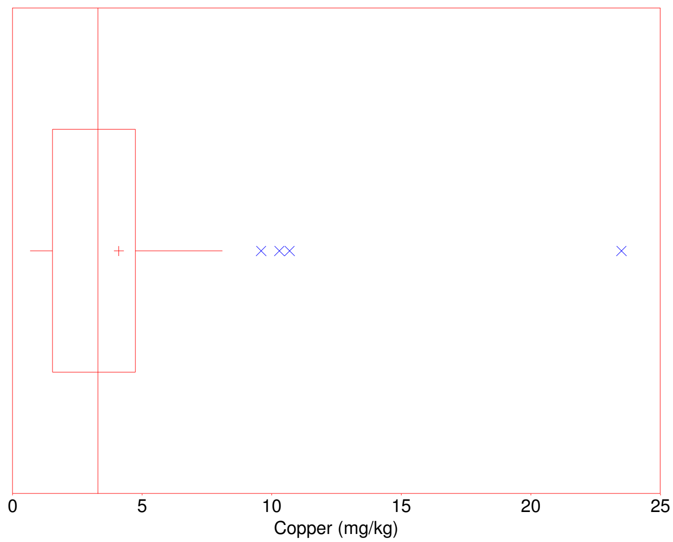
Data Plots for Copper
Graphical displays of the data are shown below.

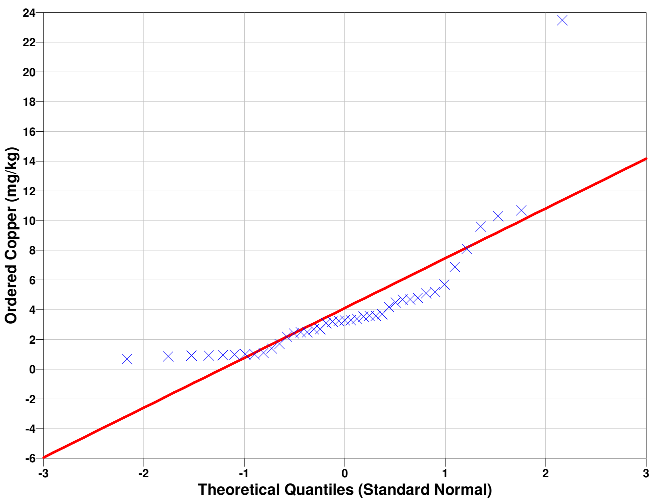
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Copper

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6979
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	5.165

95% Non-Parametric (Chebyshev) UCL	6.839

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (6.839) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-868.33	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Isopropylbenzene
The following data points were entered by the user for analysis.

Isopropylbenzene (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00065	0.00065	0.00065	0.00065	0.00065	0.0007	0.0007	0.0007	0.0007	0.0007
10	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.000725
20	0.000725	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075
30	0.00075	0.00075	0.0008	0.0008	0.00085	0.00105	0.0014	0.00235	0.0048	0.0068
40	0.0227									

SUMMARY STATISTICS for Isopropylbenzene	
n	41
Min	0.00065
Max	0.0227

Range				0.02205				
Mean				0.0015683				
Median				0.000725				
Variance				1.2763e-005				
StdDev				0.0035726				
Std Error				0.00055794				
Skewness				5.5288				
Interquartile Range				5e-005				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00065	0.00065	0.00065	0.0007	0.000725	0.00075	0.00216	0.0066	0.0227

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Isopropylbenzene			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.915	3.05	Yes

The test statistic 5.915 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Isopropylbenzene	
1	0.0227

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.3501
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

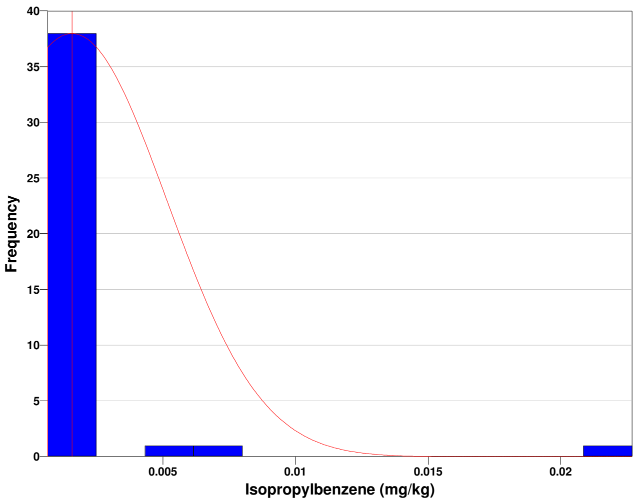
Data Plots for Isopropylbenzene
Graphical displays of the data are shown below.

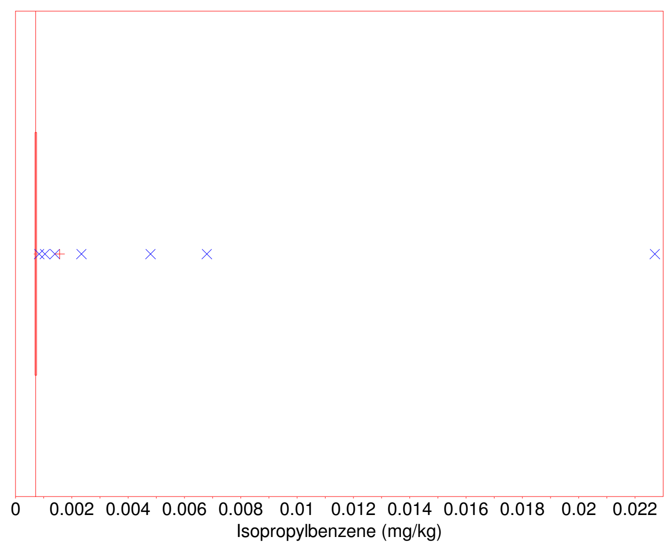
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

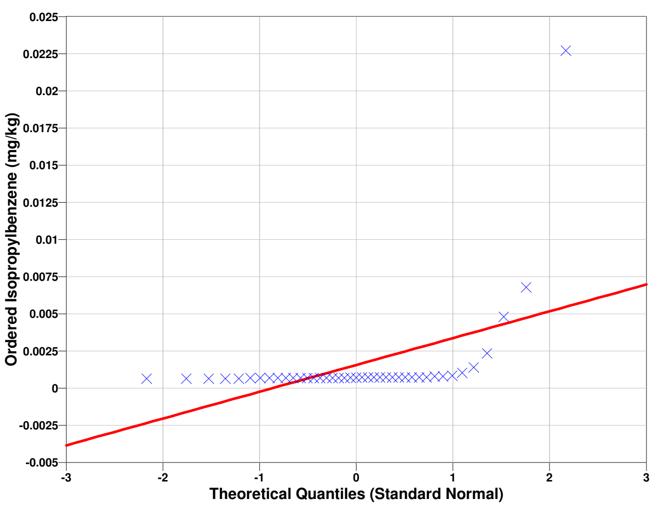
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Isopropylbenzene
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.2809
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.002508
95% Non-Parametric (Chebyshev) UCL	0.004

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.004) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-6.6465e+005	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Lead
The following data points were entered by the user for analysis.

Lead (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	2.02	2.15	2.45	2.6	3.4	3.6	3.7	3.9	4.6	4.8
10	5.1	5.4	6	6.1	6.7	6.9	6.9	7	7.2	8
20	8.3	8.9	9.2	9.8	9.9	10.4	11.6	12.7	14.8	16.1
30	17.1	17.7	18.8	18.9	19.8	20.9	22.5	23.8	55.8	80.6
40	80.7									

SUMMARY STATISTICS for Lead	
n	41
Min	2.02
Max	80.7
Range	78.68
Mean	14.313
Median	8.3
Variance	320.07
StdDev	17.891
Std Error	2.794
Skewness	2.929
Interquartile Range	12.45

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
2.02	2.18	2.76	4.95	8.3	17.4	23.54	78.12	80.7

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Lead			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.711	3.05	Yes

The test statistic 3.711 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Lead

1	80.7

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6209
Shapiro-Wilk 5% Critical Value	0.94

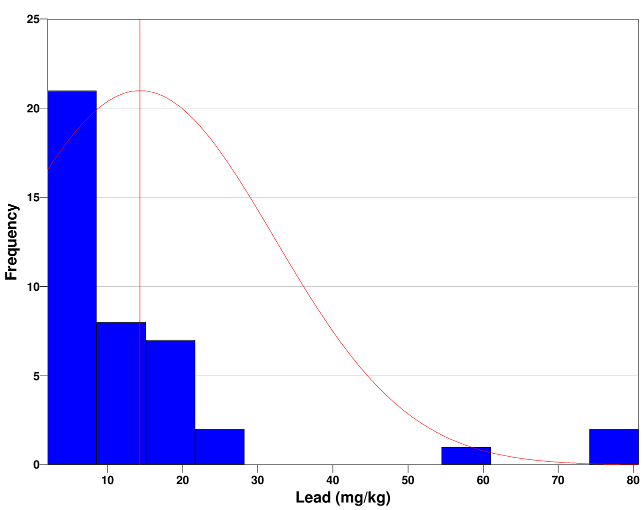
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

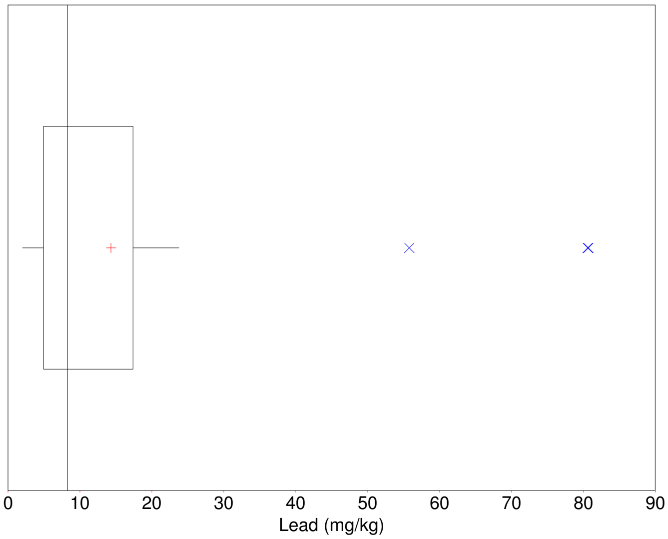
Data Plots for Lead
Graphical displays of the data are shown below.

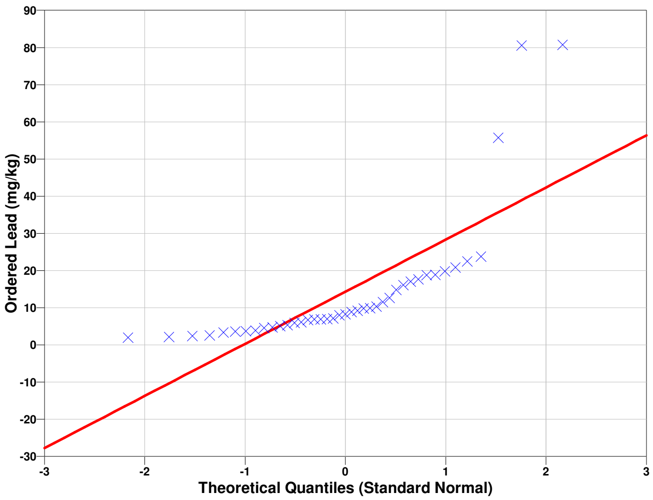
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Lead
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5993
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	19.02

95% Non-Parametric (Chebyshev) UCL	26.49

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (26.49) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-138.04	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Manganese
The following data points were entered by the user for analysis.

Manganese (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	9.3	9.3	10	11.5	15.7	17.7	21.1	21.5	26.4	27.7
10	37.3	39.6	41	42.7	43.6	47.3	49.4	49.4	65.6	66.4
20	69.4	73.6	77	77.5	80.5	92	102	102	104	106
30	110	114	121	141	143	144	146	155	191	207
40	210									

SUMMARY STATISTICS for Manganese	
n	41
Min	9.3
Max	210

Range	200.7
Mean	78.5
Median	69.4
Variance	3110.7
StdDev	55.773
Std Error	8.7103
Skewness	0.73144
Interquartile Range	79.5

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
9.3	9.37	12.34	32.5	69.4	112	153.2	205.4	210

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Manganese			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.358	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9278
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

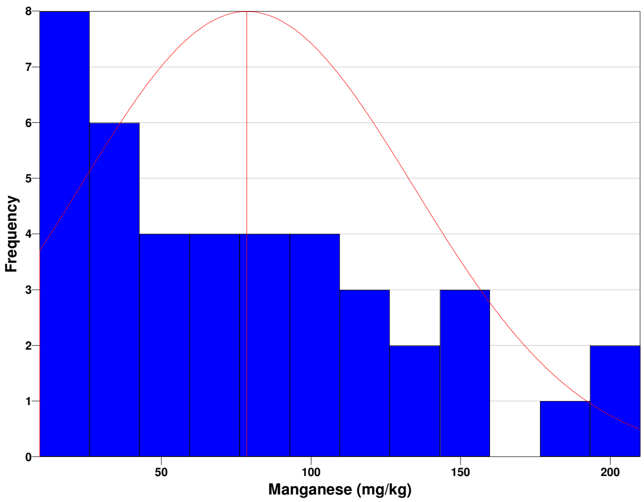
Data Plots for Manganese
Graphical displays of the data are shown below.

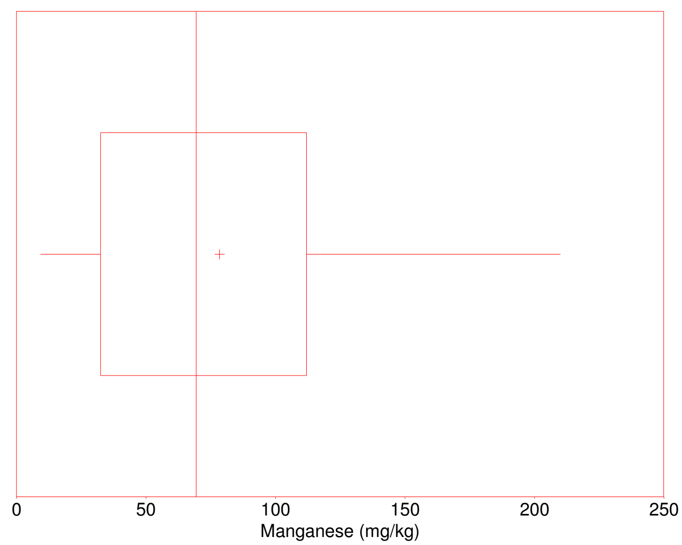
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally

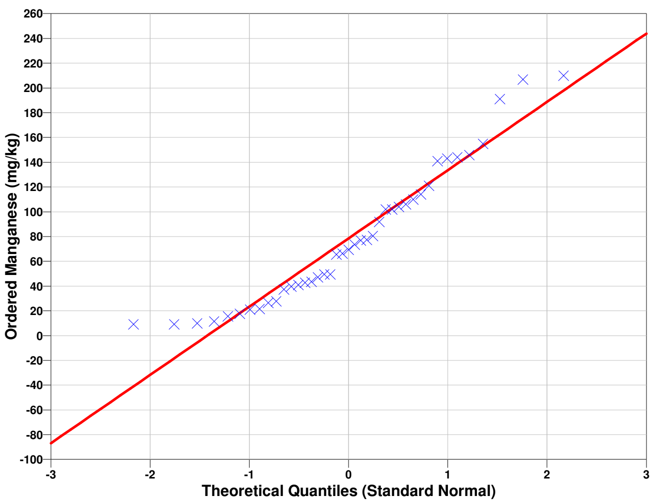
distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Manganese
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was

conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9178
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	93.17
95% Non-Parametric (Chebyshev) UCL	116.5

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (116.5) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-362.88	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Mercury
The following data points were entered by the user for analysis.

Mercury (mg/kg)

Rank	1	2	3	4	5	6	7	8	9	10
0	0.000385	0.0013	0.0014	0.0014	0.0031	0.0037	0.0047	0.00535	0.0054	0.0054
10	0.0065	0.0069	0.007	0.007	0.0072	0.0073	0.0076	0.0079	0.0082	0.0083
20	0.0088	0.0093	0.0095	0.011	0.012	0.013	0.013	0.013	0.014	0.016
30	0.016	0.019	0.0215	0.024	0.024	0.026	0.034	0.034	0.049	0.079
40	0.74									

SUMMARY STATISTICS for Mercury								
n	41							
Min	0.000385							
Max	0.74							
Range	0.73962							
Mean	0.031515							
Median	0.0088							
Variance	0.013073							
StdDev	0.11434							
Std Error	0.017856							
Skewness	6.2472							
Interquartile Range	0.01155							
Percentiles								
1%	5%	10%	25%	50%	75%	90%	95%	99%
0.000385	0.00131	0.00174	0.00595	0.0088	0.0175	0.034	0.076	0.74

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Mercury			
k	Test Statistic R_k	5% Critical Value C_k	Significant?
1	6.197	3.05	Yes

The test statistic 6.197 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Mercury	
1	0.74

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the

suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7171
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

Data Plots for Mercury
Graphical displays of the data are shown below.

The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

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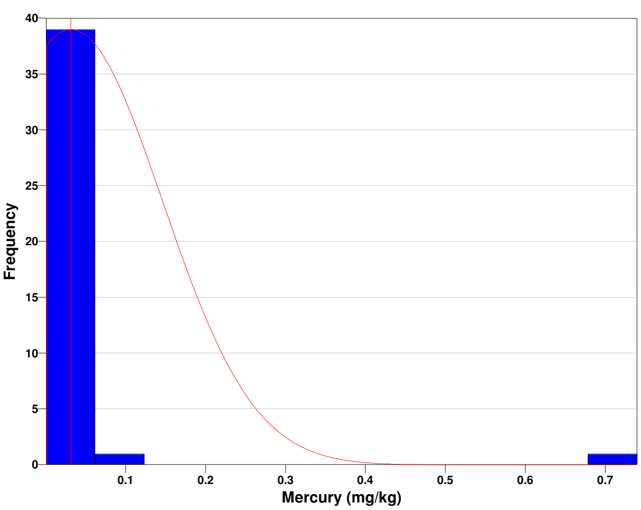
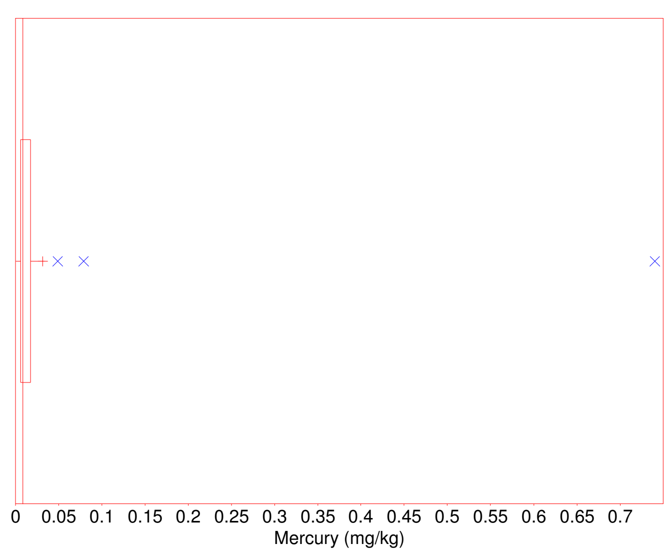
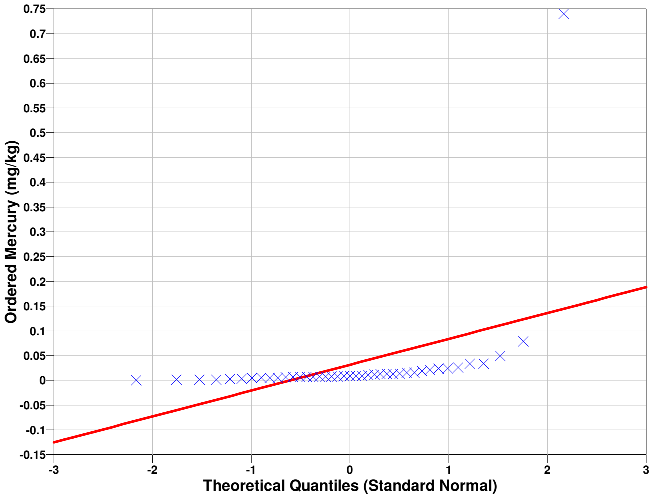






For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Mercury

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.2381
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.06158
95% Non-Parametric (Chebyshev) UCL	0.1093

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.1093) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test

A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where

x is the sample mean of the n=41 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-115.13	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Methylene chloride
The following data points were entered by the user for analysis.

Methylene chloride (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0013	0.00135	0.0014	0.0014	0.0014	0.0014	0.00143	0.00145	0.00145	0.00145
10	0.00148	0.0015	0.0015	0.0015	0.00155	0.00155	0.00155	0.00155	0.00155	0.00155
20	0.00175	0.00215	0.0034	0.0035	0.0035	0.0038	0.004	0.004	0.0041	0.0043
30	0.0048	0.0048	0.0048	0.0069	0.0096	0.0114	0.0117	0.0134	0.0176	0.0235

SUMMARY STATISTICS for Methylene chloride								
n				40				
Min				0.0013				
Max				0.0235				
Range				0.0222				
Mean				0.0043078				
Median				0.00165				
Variance				2.4195e-005				
StdDev				0.0049188				
Std Error				0.00077773				
Skewness				2.4057				
Interquartile Range				0.0032175				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0013	0.001353	0.0014	0.001458	0.00165	0.004675	0.01167	0.01739	0.0235

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test

was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Methylene chloride			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.902	3.04	Yes

The test statistic 3.902 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Methylene chloride	
1	0.0235

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6777
Shapiro-Wilk 5% Critical Value	0.939

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

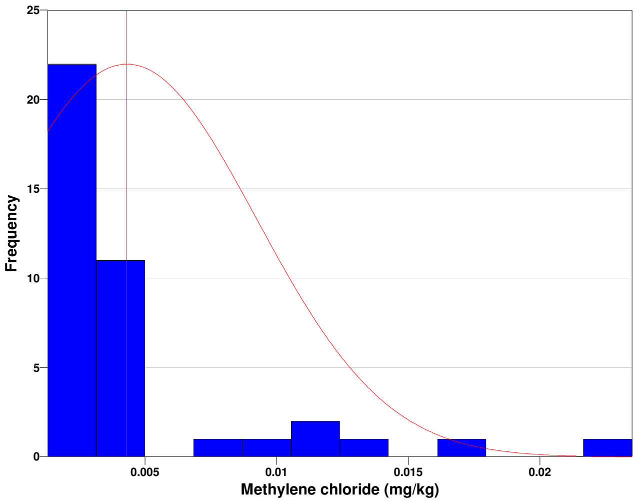
Data Plots for Methylene chloride
Graphical displays of the data are shown below.

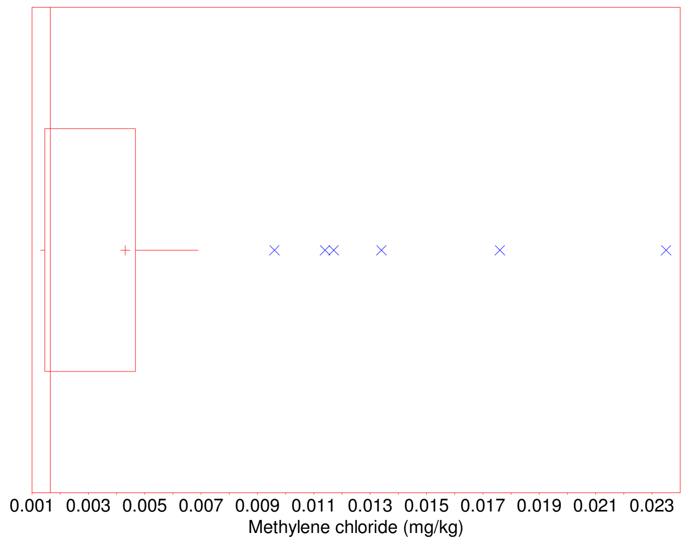
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

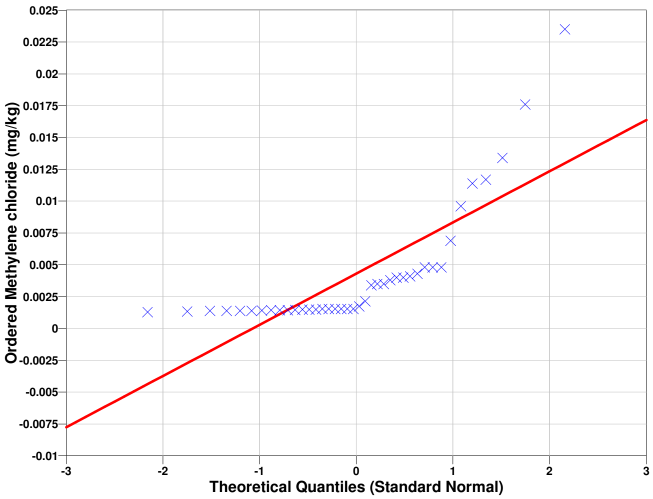
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight

line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Methylene chloride

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.651
Shapiro-Wilk 5% Critical Value	0.94

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN

95% Parametric UCL	0.005618
95% Non-Parametric (Chebyshev) UCL	0.007698

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.007698) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=40 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=39 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1616	1.6849	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
40	25	Reject

Data Analysis for Nickel
The following data points were entered by the user for analysis.

Nickel (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0775	0.26	0.27	0.29	0.35	0.48	0.56	0.76	0.81	1
10	1.1	1.2	1.2	1.3	1.3	1.5	1.7	1.8	1.9	2
20	2.1	2.2	2.2	2.4	2.5	2.7	2.95	3.05	3.3	3.4
30	3.4	3.5	4.1	4.2	4.3	4.45	5.1	5.2	5.3	8.6
40	9.3									

SUMMARY STATISTICS for Nickel	
n	41
Min	0.0775

Max	9.3
Range	9.2225
Mean	2.5392
Median	2.1
Variance	4.3557
StdDev	2.087
Std Error	0.32594
Skewness	1.4641
Interquartile Range	2.4

Percentiles

1%	5%	10%	25%	50%	75%	90%	95%	99%
0.0775	0.261	0.302	1.05	2.1	3.45	5.18	8.27	9.3

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Nickel			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.239	3.05	Yes

The test statistic 3.239 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Nickel	
1	9.3

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9125
Shapiro-Wilk 5% Critical Value	0.94

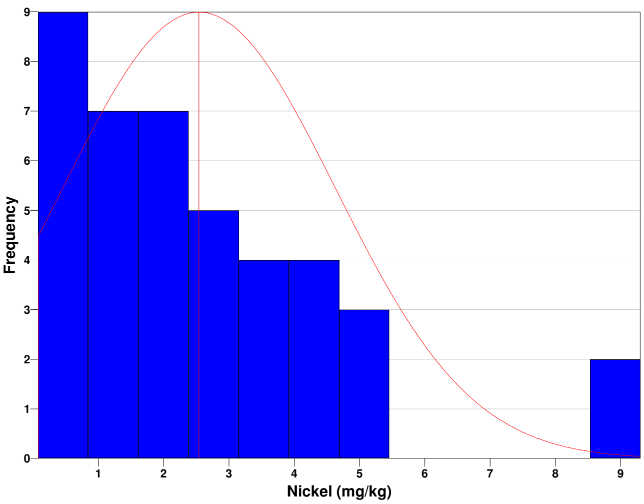
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

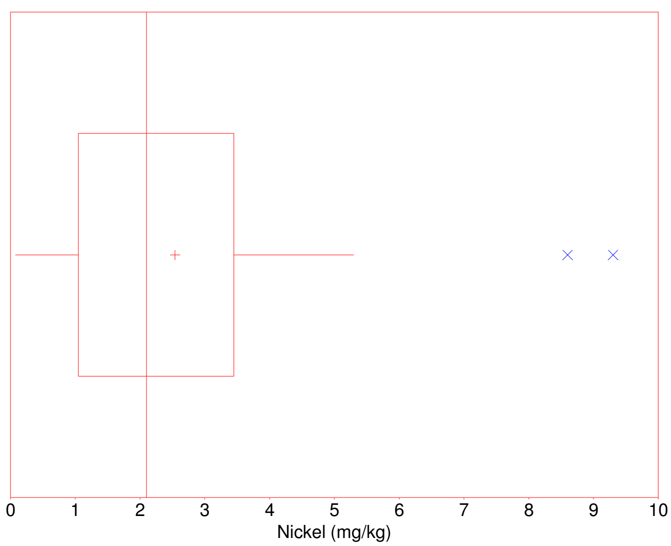
Data Plots for Nickel
Graphical displays of the data are shown below.

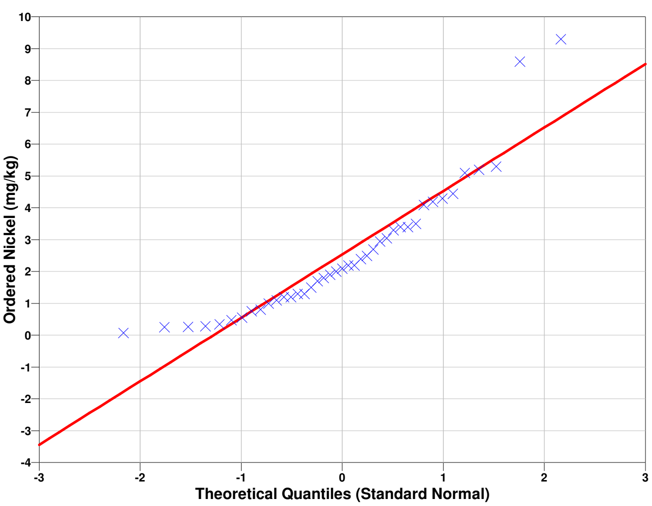
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through

2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Nickel
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8731
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	3.088
95% Non-Parametric (Chebyshev) UCL	3.96

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (3.96) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-2545.2	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Phenanthrene
The following data points were entered by the user for analysis.

Phenanthrene (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.034	0.035	0.0355	0.036	0.036	0.036	0.0365	0.037	0.037	0.037
10	0.037	0.0375	0.0375	0.0378	0.038	0.038	0.038	0.0385	0.0388	0.039
20	0.039	0.0395	0.04	0.04	0.04	0.0405	0.041	0.041	0.042	0.042
30	0.0425	0.055	0.147	0.355	0.36	0.37	0.39	0.398	0.407	0.679
40	2.06									

SUMMARY STATISTICS for Phenanthrene	
n	41
Min	0.034
Max	2.06
Range	2.026
Mean	0.15631
Median	0.039
Variance	0.11605
StdDev	0.34066
Std Error	0.053202
Skewness	4.6927
Interquartile Range	0.01175

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.034	0.03505	0.036	0.037	0.039	0.04875	0.3964	0.6518	2.06

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Phenanthrene			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.588	3.05	Yes

The test statistic 5.588 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Phenanthrene

1	2.06

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5336
Shapiro-Wilk 5% Critical Value	0.94

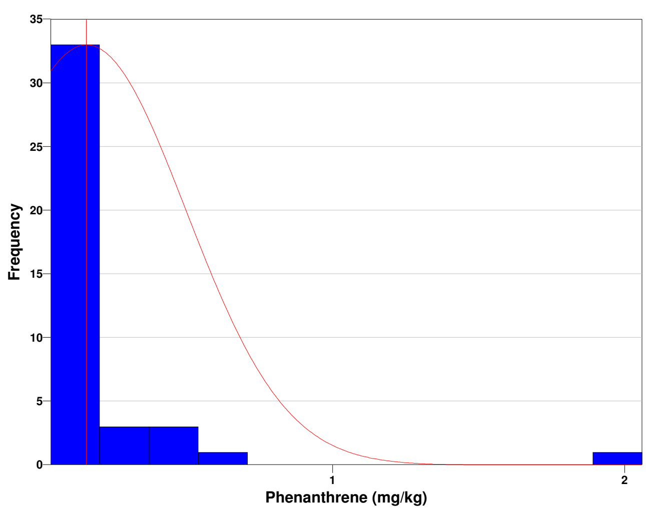
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

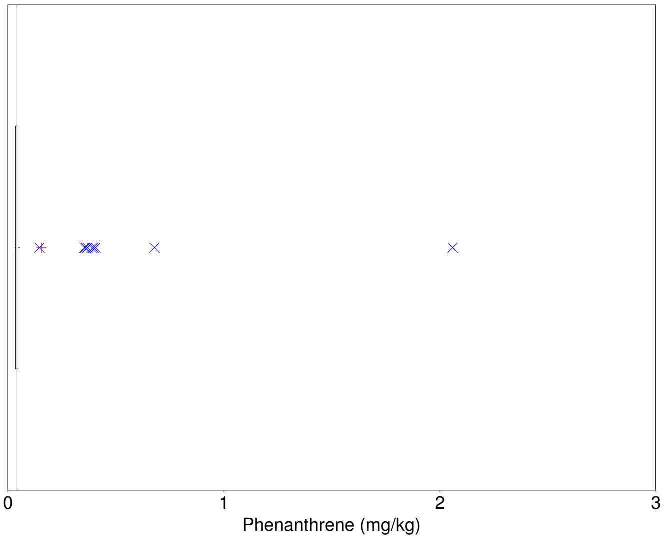
Data Plots for Phenanthrene
Graphical displays of the data are shown below.

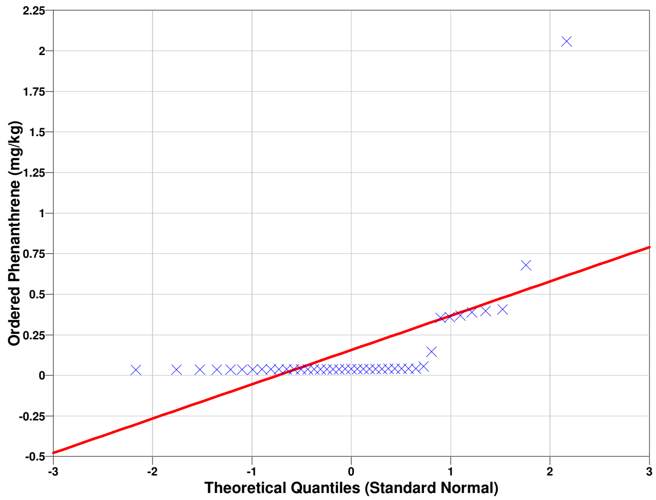
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Phenanthrene
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.4048
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.2459

95% Non-Parametric (Chebyshev) UCL	0.3882

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.3882) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-32049	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Pyrene
The following data points were entered by the user for analysis.

Pyrene (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0445	0.046	0.0475	0.0475	0.0475	0.048	0.048	0.0485	0.0485	0.0485
10	0.049	0.049	0.0495	0.0498	0.05	0.05	0.05	0.05	0.05	0.05
20	0.05	0.05	0.0525	0.0535	0.055	0.055	0.055	0.055	0.055	0.055
30	0.07	0.237	0.336	0.355	0.465	0.475	0.485	0.5	0.525	0.55
40	1.58									

SUMMARY STATISTICS for Pyrene	
n	41
Min	0.0445
Max	1.58

Range	1.5355
Mean	0.17282
Median	0.05
Variance	0.078826
StdDev	0.28076
Std Error	0.043847
Skewness	3.5104
Interquartile Range	0.10475

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0445	0.04615	0.0475	0.04875	0.05	0.1535	0.497	0.5475	1.58

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Pyrene			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.012	3.05	Yes

The test statistic 5.012 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Pyrene	
1	1.58

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5639
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

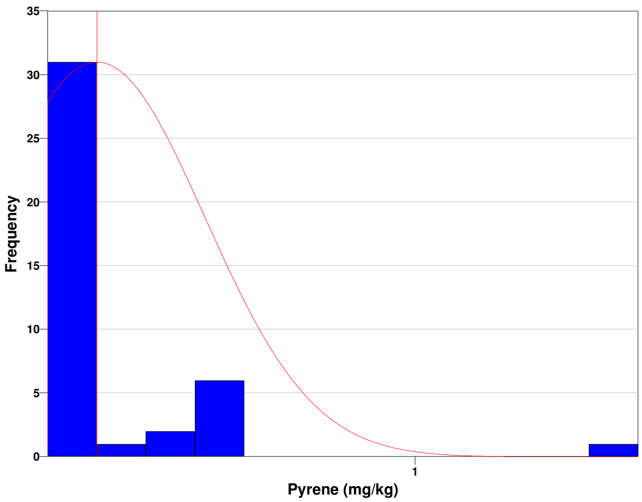
Data Plots for Pyrene
Graphical displays of the data are shown below.

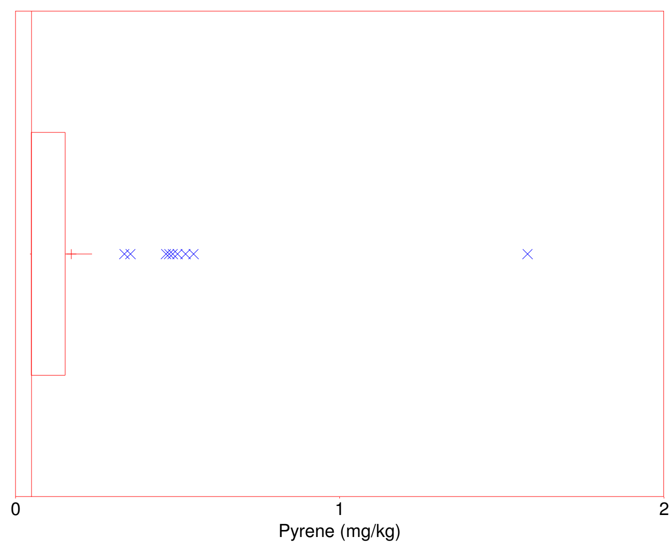
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

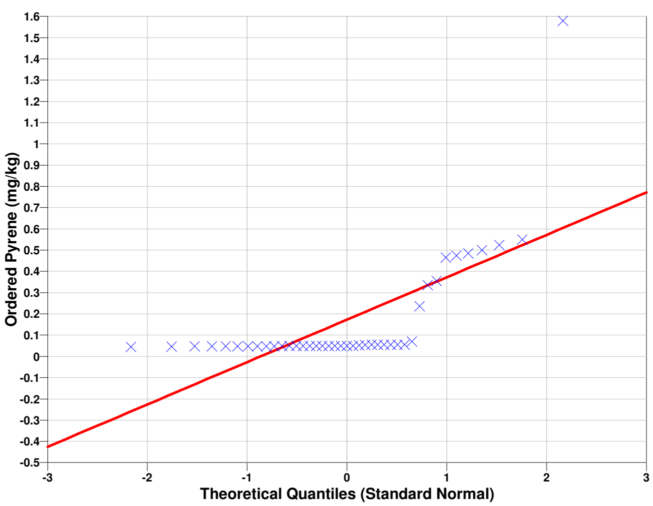
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Pyrene
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5125
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.2467
95% Non-Parametric (Chebyshev) UCL	0.3639

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.3639) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-38713	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Toluene
The following data points were entered by the user for analysis.

Toluene (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00065	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.00075	0.00075
10	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.000775	0.0008
20	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
30	0.0008	0.0008	0.0008	0.00085	0.00085	0.0009	0.0011	0.0014	0.0015	0.0039
40	0.0044									

SUMMARY STATISTICS for Toluene								
n	41							
Min	0.00065							
Max	0.0044							
Range	0.00375							
Mean	0.00097378							
Median	0.0008							
Variance	5.6012e-007							
StdDev	0.00074841							
Std Error	0.00011688							
Skewness	4.0831							
Interquartile Range	5e-005							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00065	0.0007	0.0007	0.00075	0.0008	0.0008	0.00134	0.00366	0.0044

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Toluene			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.578	3.05	Yes

The test statistic 4.578 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Toluene

1	0.0044

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.3454
Shapiro-Wilk 5% Critical Value	0.94

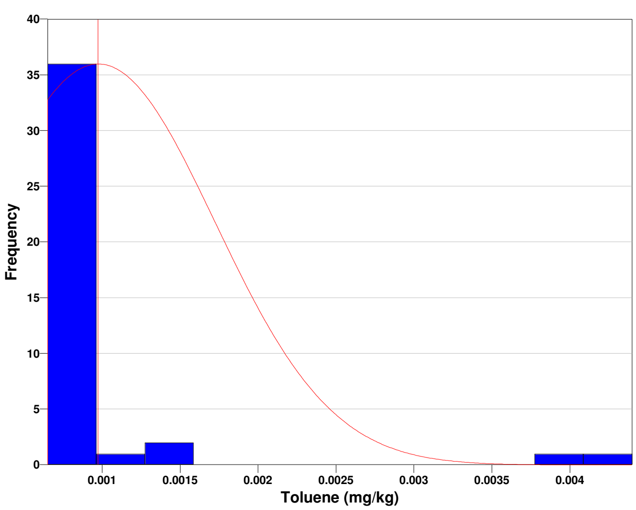
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

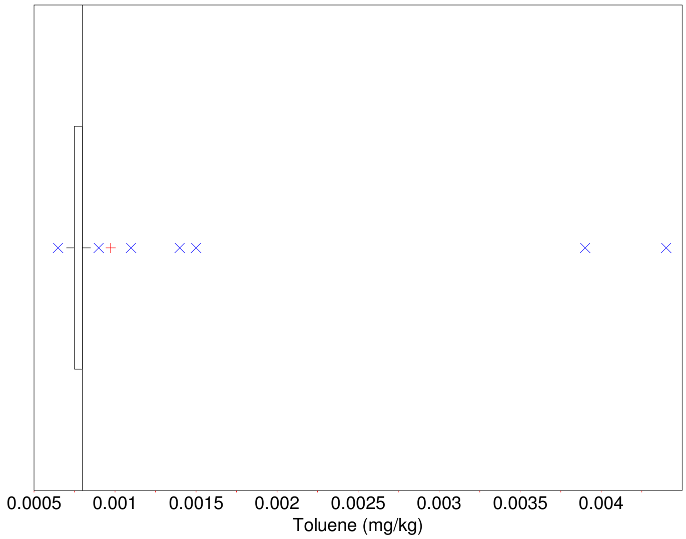
Data Plots for Toluene
Graphical displays of the data are shown below.

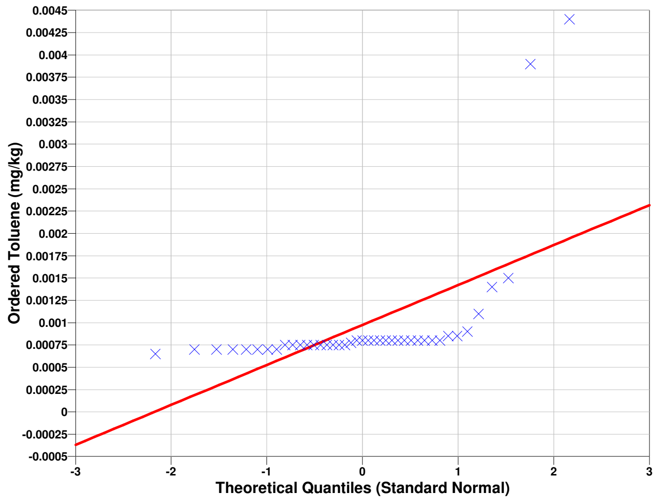
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Toluene
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.3684
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.001171

95% Non-Parametric (Chebyshev) UCL	0.001483

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.001483) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-4.4589e+006	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Vanadium
The following data points were entered by the user for analysis.

Vanadium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.985	1.1	1.1	1.3	1.6	1.7	2.1	2.3	2.4	2.4
10	2.93	3.5	4.1	4.1	4.5	4.7	4.8	4.9	5.1	5.1
20	5.25	5.8	6.1	6.6	6.85	7	7.7	7.8	9.1	9.6
30	10.5	10.6	12.8	13.2	15.8	16	16.2	16.6	17.3	22.3
40	29.3									

SUMMARY STATISTICS for Vanadium	
n	41
Min	0.985
Max	29.3

Range	28.315
Mean	7.637
Median	5.25
Variance	40.719
StdDev	6.3812
Std Error	0.99657
Skewness	1.4668
Interquartile Range	7.885

Percentiles

1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.985	1.1	1.36	2.665	5.25	10.55	16.52	21.8	29.3

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Vanadium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.395	3.05	Yes

The test statistic 3.395 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Vanadium	
1	29.3

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8818
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

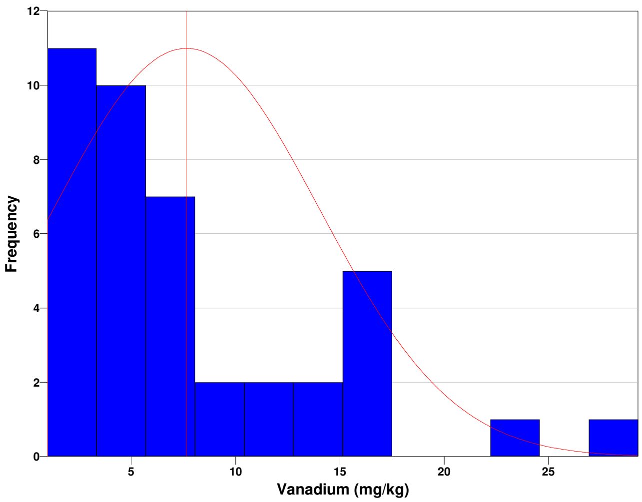
Data Plots for Vanadium
Graphical displays of the data are shown below.

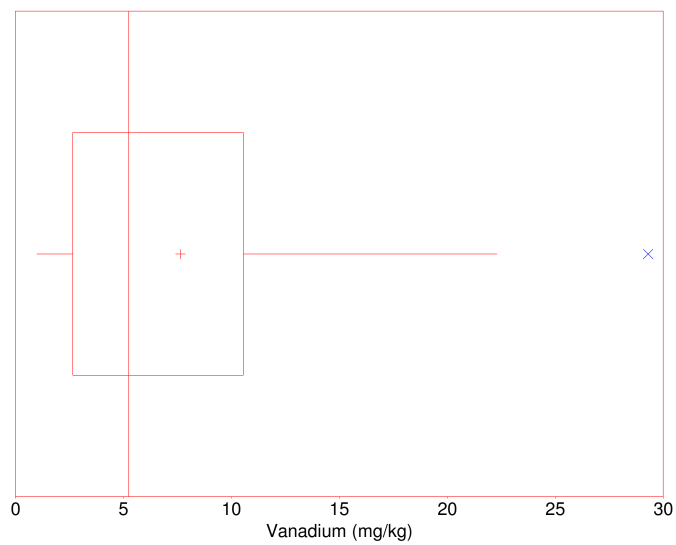
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

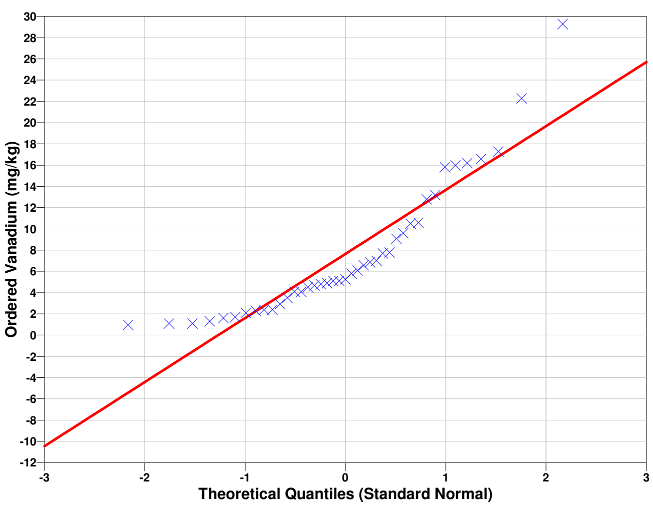
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Vanadium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8548
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	9.315
95% Non-Parametric (Chebyshev) UCL	11.98

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (11.98) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-284.35	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Xylene (total)
The following data points were entered by the user for analysis.

Xylene (total) (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.002	0.00205	0.00205	0.00205	0.00215	0.00215	0.00215	0.00215	0.00215	0.0022
10	0.0022	0.0022	0.0022	0.00225	0.00225	0.0023	0.0023	0.0023	0.0023	0.00235
20	0.00235	0.00235	0.00235	0.00238	0.00238	0.0024	0.0024	0.0024	0.0024	0.00245
30	0.0025	0.0026	0.00265	0.0033	0.0047	0.0048	0.005	0.0056	0.0057	0.0062
40	0.0077									

SUMMARY STATISTICS for Xylene (total)	
n	41
Min	0.002
Max	0.0077
Range	0.0057
Mean	0.0028868
Median	0.00235
Variance	1.8443e-006
StdDev	0.0013581
Std Error	0.00021209
Skewness	2.1404
Interquartile Range	0.00035

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.002	0.00205	0.00207	0.0022	0.00235	0.00255	0.00548	0.00615	0.0077

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Xylene (total)			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.544	3.05	Yes

The test statistic 3.544 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Xylene (total)

1	0.0077

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5979
Shapiro-Wilk 5% Critical Value	0.94

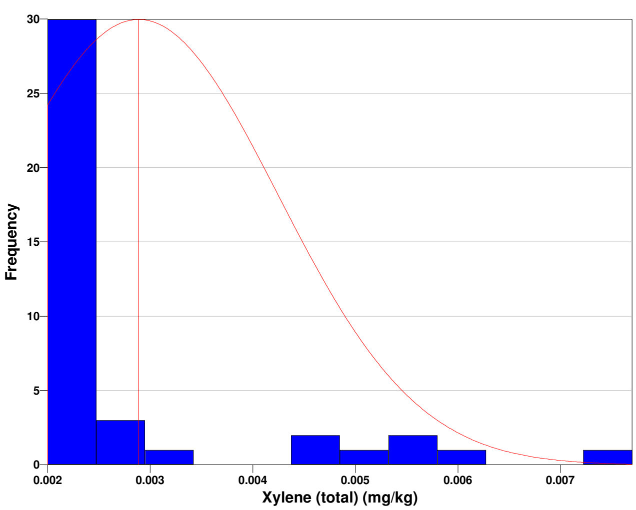
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

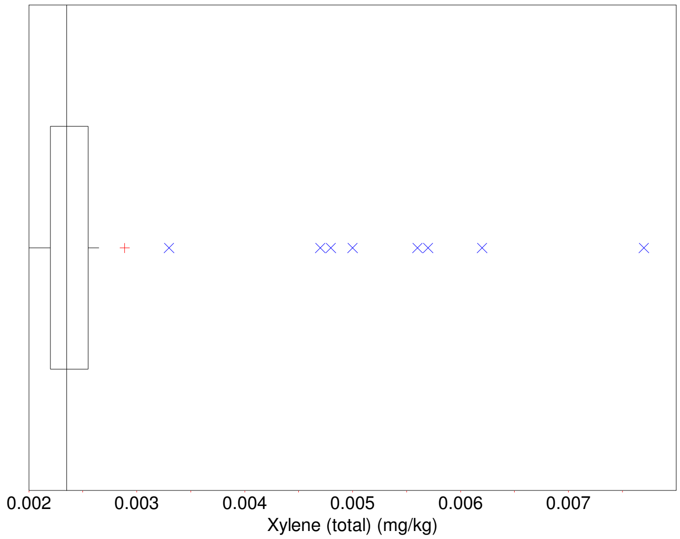
Data Plots for Xylene (total)
Graphical displays of the data are shown below.

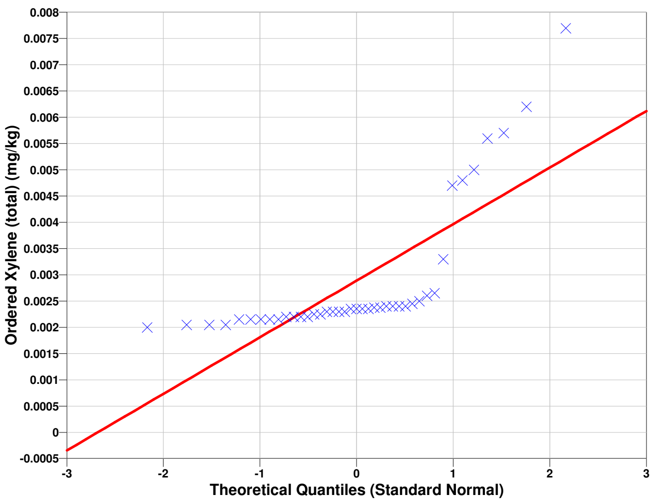
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Xylene (total)
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6112
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.003244

95% Non-Parametric (Chebyshev) UCL	0.003811

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.003811) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.0112e+006	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Zinc
The following data points were entered by the user for analysis.

Zinc (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	3.1	6.1	8.7	10.4	10.6	11.1	12.2	16.6	17.2	19.7
10	20.1	22.2	22.8	23.6	25.2	25.9	26.1	26.2	29.4	29.8
20	30.2	31.1	31.8	35	39.5	40.2	40.7	40.7	44.1	48
30	48.5	59	59	79	80.3	85.3	92.6	129	143	156
40	232									

SUMMARY STATISTICS for Zinc	
n	41
Min	3.1
Max	232

Range				228.9				
Mean				46.634				
Median				30.2				
Variance				2169.2				
StdDev				46.575				
Std Error				7.2737				
Skewness				2.2859				
Interquartile Range				33.85				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
3.1	6.36	10.44	19.9	30.2	53.75	121.7	154.7	232

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Zinc			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.98	3.05	Yes

The test statistic 3.98 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Zinc	
1	232

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.799
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

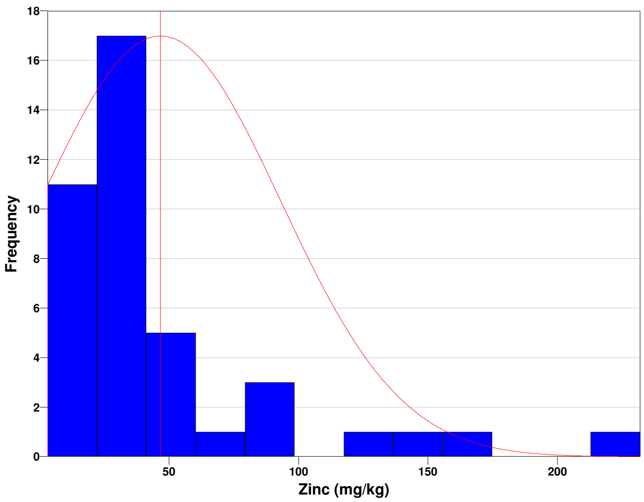
Data Plots for Zinc
Graphical displays of the data are shown below.

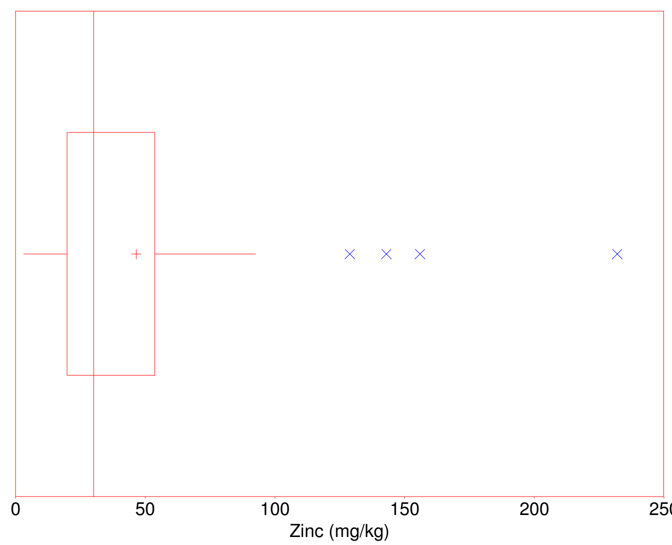
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

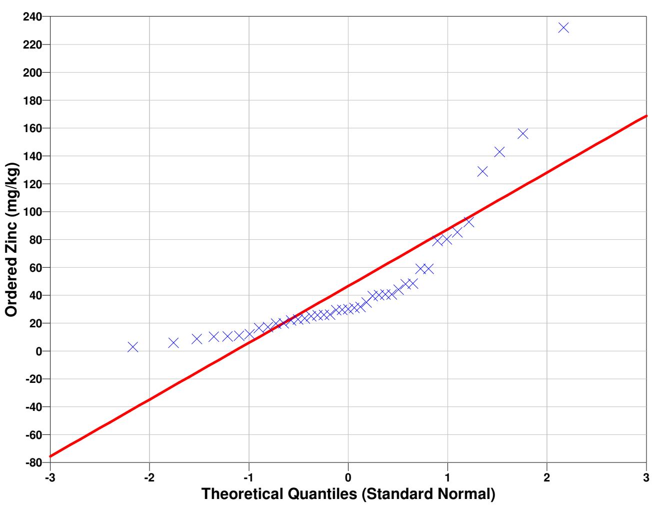
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Zinc
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7459
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	58.88
95% Non-Parametric (Chebyshev) UCL	78.34

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (78.34) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1357.6	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Appendix C

VSP Reports of Calculated Minimum Sample Quantity
Report 3
Area of Concern – 1
Minimum Sample Quantity Calculation for Surface Soil using Ecological Benchmarks and Delta Method 1

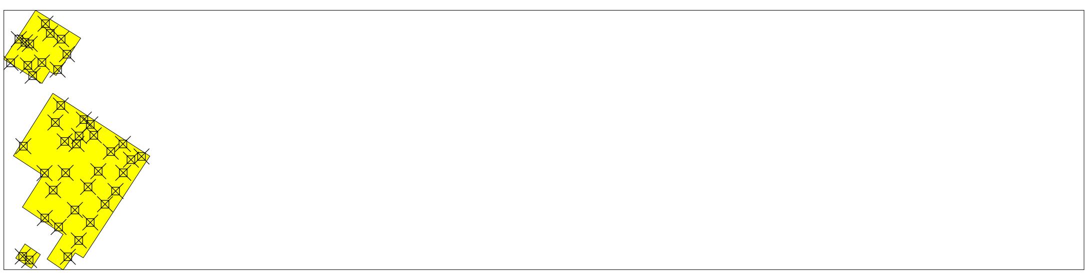
Random sampling locations for comparing a mean with a fixed threshold (parametric)

Summary
This report summarizes the sampling design, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design for Mercury, the driving analyte (the analyte which required the largest number of samples). A figure that shows sampling locations in the field and a table that lists sampling location coordinates are also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean to a fixed threshold
Type of Sampling Design	Parametric
Sample Placement (Location) in the Field	Simple random sampling
Working (Null) Hypothesis	The mean value at the site exceeds the threshold
Formula for calculating number of sampling locations	Student's t-test
Calculated total number of samples	26
Number of samples on map [a]	41
Number of selected sample areas [b]	1
Specified sampling area [c]	188054.34 m^2
Total cost of sampling [d]	$14,000.00

[a] This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[d] Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.



Area: Area 3					
X Coord	Y Coord	Label	Value	Type	Historical
679149.4920	3082933.0980	J-13S		Manual	T
679279.6830	3083075.4290	J-14S		Manual	T
679261.0980	3083016.3510	J-15S		Manual	T
679222.6340	3082840.1720	J-16S		Manual	T

679293.5600	3082950.4980	J-17S		Manual	T
679360.5700	3083026.4980	J-18S		Manual	T
679343.5810	3082969.5980	J-19S		Manual	T
679382.8640	3083009.1130	J-20S		Manual	T
679335.0020	3082941.1720	J-21S		Manual	T
679252.7130	3082781.0290	J-22S		Manual	T
679297.0010	3082840.6970	J-23S		Manual	T
679394.8070	3082971.8300	J-24S		Manual	T
679146.6460	3082549.7640	J-25S		Manual	T
679224.5850	3082683.1400	J-26S		Manual	T
679169.0760	3082537.3510	J-27S		Manual	T
679272.0040	3082652.6750	J-28S		Manual	T
679329.4380	3082711.0960	J-29S		Manual	T
679374.4420	3082791.3300	J-30S		Manual	T
679410.1490	3082845.8460	J-31S		Manual	T
679453.4760	3082914.1150	J-32S		Manual	T
679495.8840	3082940.9730	J-33S		Manual	T
679304.6530	3082548.6880	J-34S		Manual	T
679342.7410	3082605.3190	J-35S		Manual	T
679382.8900	3082667.5270	J-36S		Manual	T
679433.9450	3082731.6820	J-37S		Manual	T
679470.3570	3082776.7350	J-38S		Manual	T
679497.3310	3082840.3960	J-39S		Manual	T
679524.3310	3082886.8990	J-40S		Manual	T
679560.6070	3082897.2580	J-41S		Manual	T
679133.4290	3083306.3130	J-01S		Manual	T
679104.2450	3083223.2620	J-02S		Manual	T
679155.0740	3083294.6960	J-03S		Manual	T
679171.2970	3083289.7960	J-04S		Manual	T
679225.8560	3083359.9740	J-05S		Manual	T
679164.8060	3083214.7100	J-06S		Manual	T
679242.7260	3083326.5280	J-07S		Manual	T
679181.2750	3083178.2880	J-08S		Manual	T
679213.7730	3083224.9730	J-09S		Manual	T
679280.5440	3083305.6810	J-10S		Manual	T
679268.7700	3083200.3260	J-11S		Manual	T
679301.1600	3083254.0340	J-12S		Manual	T

Primary Sampling Objective

The primary purpose of sampling at this site is to compare a mean value of a site with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the mean value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the mean value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative hypothesis, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach
A parametric random sampling approach was used to determine the number of samples and to specify sampling locations. A parametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that parametric assumptions are reasonable. These assumptions will be examined in post-sampling data analysis.

Both parametric and non-parametric approaches rely on assumptions about the population. However, non-parametric approaches typically require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than the number of samples required by non-parametric approaches.

Locating the sample points randomly provides data that are separated by many distances, whereas systematic samples are all equidistant apart. Therefore, random sampling provides more information about the spatial structure of the potential contamination than systematic sampling does. As with systematic sampling, random sampling also provides information regarding the mean value, but there is the possibility that areas of the site will not be represented with the same frequency as if uniform grid sampling were performed.

Number of Total Samples: Calculation Equation and Inputs
The equation used to calculate the number of samples is based on a Student's t-test. For this site, the null hypothesis is rejected in favor of the alternative hypothesis if the sample mean is sufficiently smaller than the threshold. The number of samples to collect is calculated so that 1) there will be a high probability ($1-\beta$) of rejecting the null hypothesis if the alternative hypothesis is true and 2) a low probability (α) of rejecting the null hypothesis if the null hypothesis is true.

The formula used to calculate the number of samples is:

$$n = \frac{S^2}{\Delta^2}\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2 + 0.5Z_{1-\alpha}^2$$

where
n is the number of samples,
S is the estimated standard deviation of the measured values including analytical error,
Δ is the width of the gray region,
α is the acceptable probability of incorrectly concluding the site mean is less than the threshold,
β is the acceptable probability of incorrectly concluding the site mean exceeds the threshold,
$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is $1-\alpha$,
$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is $1-\beta$.

The values of these inputs that result in the calculated number of sampling locations are:

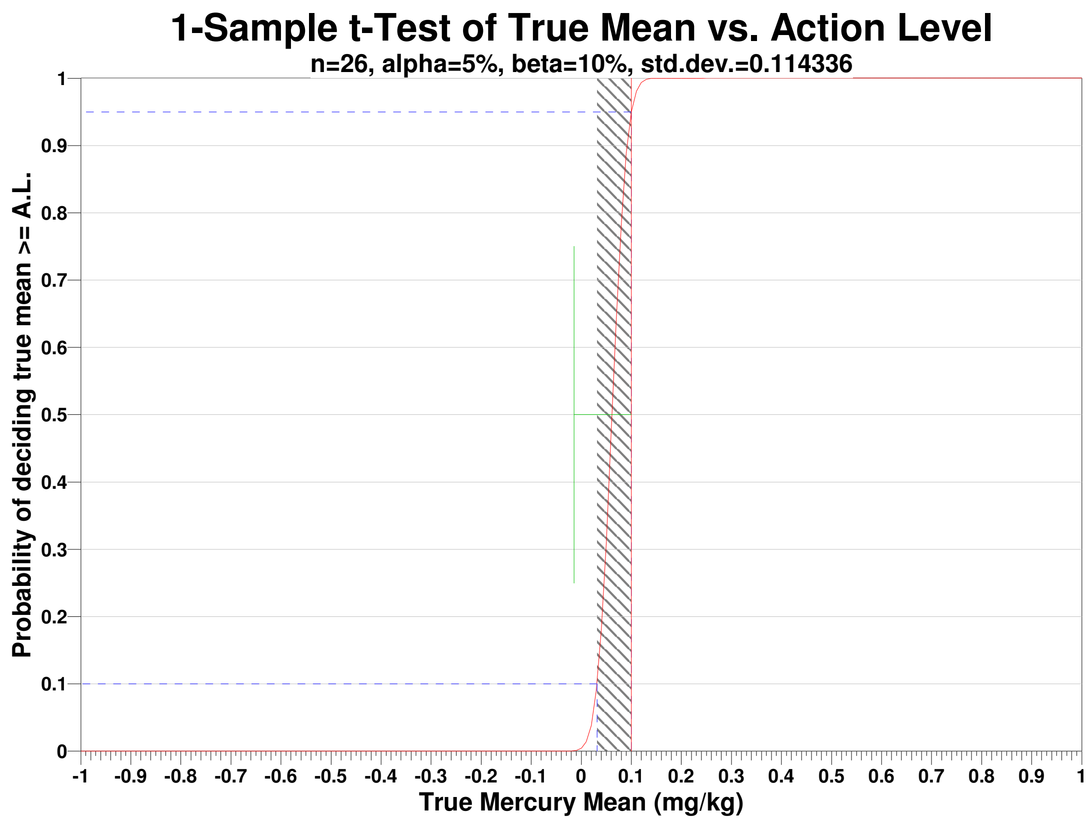
Analyte	n	Parameter					
		S	Δ	α	β	$Z_{1-\alpha}$ [a]	$Z_{1-\beta}$ [b]
New Location	2	0.1 mg/kg	10 mg/kg	0.05	0.1	1.64485	1.28155
Arsenic	2	0.899292 mg/kg	16.7542 mg/kg	0.05	0.1	1.64485	1.28155
Barium	13	234.679 mg/kg	201.627 mg/kg	0.05	0.1	1.64485	1.28155
Beryllium	2	0.180444 mg/kg	9.80197 mg/kg	0.05	0.1	1.64485	1.28155
Cadmium	2	0.181351 mg/kg	31.894 mg/kg	0.05	0.1	1.64485	1.28155
Chromium	7	3.52689 mg/kg	4.57705 mg/kg	0.05	0.1	1.64485	1.28155
Cobalt	2	0.998894 mg/kg	11.7074 mg/kg	0.05	0.1	1.64485	1.28155
Copper	2	4.00774 mg/kg	56.889 mg/kg	0.05	0.1	1.64485	1.28155
Lead	2	17.8896 mg/kg	105.691 mg/kg	0.05	0.1	1.64485	1.28155
Manganese	2	55.7772 mg/kg	421.495 mg/kg	0.05	0.1	1.64485	1.28155
Mercury	26	0.114336 mg/kg	0.0684845 mg/kg	0.05	0.1	1.64485	1.28155

Nickel	2	2.08703 mg/kg	27.4608 mg/kg	0.05	0.1	1.64485	1.28155
Toluene	2	0.000748414 mg/kg	199.999 mg/kg	0.05	0.1	1.64485	1.28155
Vanadium	13	6.37936 mg/kg	5.63561 mg/kg	0.05	0.1	1.64485	1.28155
Zinc	5	46.5764 mg/kg	73.3704 mg/kg	0.05	0.1	1.64485	1.28155

[a] This value is automatically calculated by VSP based upon the user defined value of α.
[b] This value is automatically calculated by VSP based upon the user defined value of β.

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000) for Mercury, the driving analyte. It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true mean values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at 1-α on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at 1-α. If any of the inputs change, the number of samples that result in the correct curve changes.



Statistical Assumptions

The assumptions associated with the formulas for computing the number of samples are:

1. the sample mean is normally distributed (this happens if the data are roughly symmetric or the sample size is more than 30; for extremely skewed data sets, additional samples may be required for the sample mean to be normally distributed),
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected randomly.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the sample locations were selected using a random process.

Sensitivity Analysis
The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that μ > action level and alpha (%), probability of mistakenly concluding that μ < action level. The following table shows the results of this analysis.

Number of Samples							
AL=120		α=5		α=10		α=15	
		s=93.1528	s=46.5764	s=93.1528	s=46.5764	s=93.1528	s=46.5764
LBGR=90	β=5	939088090	234772024	743123072	185780769	623847499	155961875
	β=10	743123073	185780770	570064492	142516124	466243783	116560946
	β=15	623847500	155961876	466243783	116560947	372850398	93212600
LBGR=80	β=5	234772024	58693007	185780769	46445193	155961875	38990470
	β=10	185780770	46445194	142516124	35629032	116560946	29140237
	β=15	155961876	38990470	116560947	29140238	93212600	23303151
LBGR=70	β=5	104343123	26085782	82569231	20642309	69316390	17329098
	β=10	82569232	20642309	63340500	15835126	51804866	12951217
	β=15	69316390	17329099	51804866	12951217	41427823	10356957

s = Standard Deviation
LBGR = Lower Bound of Gray Region (% of Action Level)
β = Beta (%), Probability of mistakenly concluding that μ > action level
α = Alpha (%), Probability of mistakenly concluding that μ < action level
AL = Action Level (Threshold)

Cost of Sampling
The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that are based on the number of samples collected and measured. Based on the numbers of samples determined above, the estimated total cost of sampling and analysis at this site is $14,000.00, which averages out to a per sample cost of $538.46. The following table summarizes the inputs and resulting cost estimates.

COST INFORMATION			
Cost Details	**Per Analysis**	**Per Sample**	**26 Samples**
Field collection costs		$100.00	$2,600.00
Analytical costs	$400.00	$400.00	$10,400.00
Sum of Field & Analytical costs		**$500.00**	**$13,000.00**
Fixed planning and validation costs			$1,000.00
Total cost			**$14,000.00**

Data Analysis for New Location

SUMMARY STATISTICS for New Location	
n	2624
Min	0
Max	0
Range	0
Mean	0

Median				0				
Variance				0				
StdDev				0				
Std Error				0				
Skewness				-1.#IND				
Interquartile Range				0				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0	0	0	0	0	0	0	0	0

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for New Location			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	-1.#IO	4.261	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Lilliefors test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Lilliefors Test Statistic	0
Lilliefors 5% Critical Value	0.0173

The calculated Lilliefors test statistic is less than the 5% Lilliefors critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do appear to follow a normal distribution at the 5% level of significance.

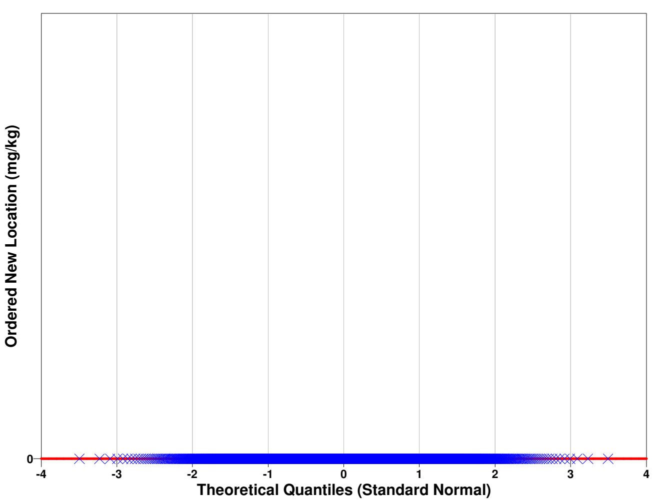
Data Plots for New Location
Graphical displays of the data are shown below.

The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends

to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.



For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for New Location

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Lilliefors test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Lilliefors Test Statistic	0
Lilliefors 5% Critical Value	0.0173

The calculated Lilliefors test statistic is less than the 5% Lilliefors critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0
95% Non-Parametric (Chebyshev) UCL	0

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=2624 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=2623 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.#IND	1.6454	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Data Analysis for Arsenic
The following data points were entered by the user for analysis.

Arsenic (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.09	0.11	0.12	0.22	0.23	0.278	0.29	0.305	0.31	0.35
10	0.51	0.53	0.57	0.58	0.66	0.72	0.83	0.86	0.93	1.04
20	1.1	1.2	1.3	1.3	1.4	1.45	1.5	1.6	1.7	1.8
30	2	2	2	2.2	2.4	2.5	2.6	2.6	2.8	3
40	3.1									

SUMMARY STATISTICS for Arsenic	
n	41

Min	0.09
Max	3.1
Range	3.01
Mean	1.2459
Median	1.1
Variance	0.80868
StdDev	0.89926
Std Error	0.14044
Skewness	0.50174
Interquartile Range	1.57

Percentiles

1%	5%	10%	25%	50%	75%	90%	95%	99%
0.09	0.111	0.222	0.43	1.1	2	2.6	2.98	3.1

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Arsenic			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.062	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.92
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

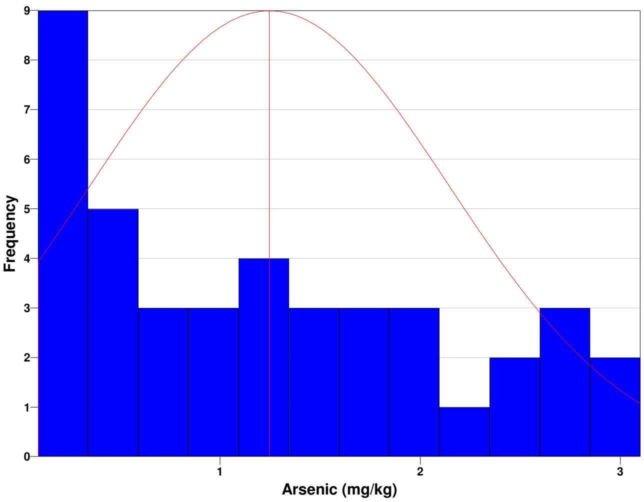
Data Plots for Arsenic
Graphical displays of the data are shown below.

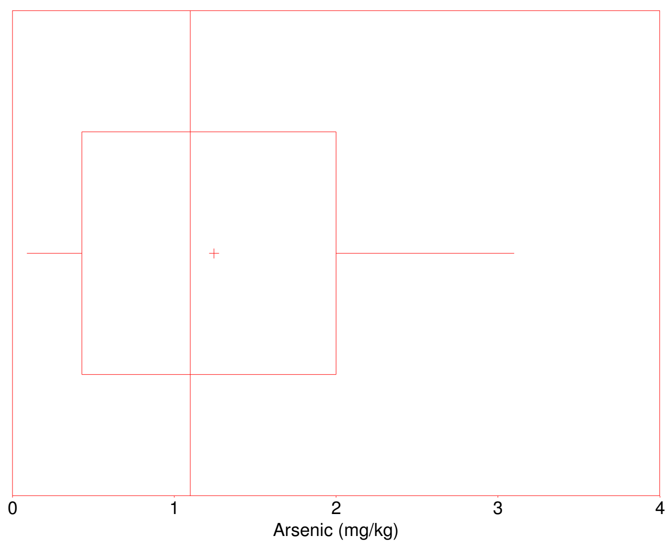
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each

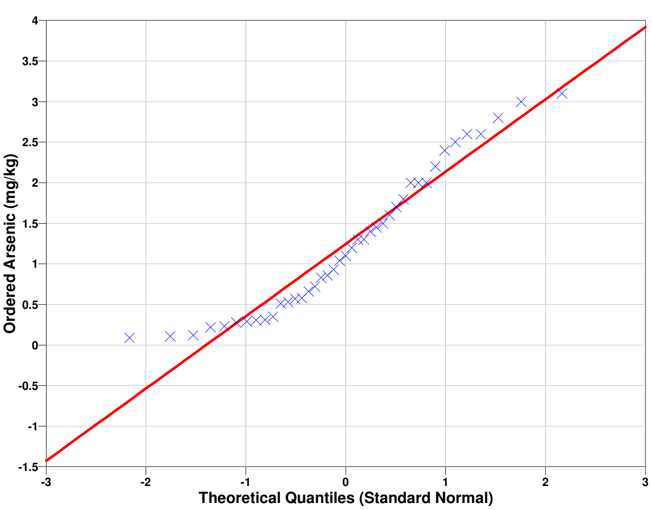
bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Arsenic
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.918
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	1.482
95% Non-Parametric (Chebyshev) UCL	1.858

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (1.858) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-119.3	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Barium
The following data points were entered by the user for analysis.

Barium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	6.25	13.7	13.9	19	23.4	25.9	26.9	28.4	30.2	31.4
10	36	36.1	36.7	39.9	41.4	53.5	60.3	61.5	61.7	63.5
20	64.5	66.6	67.1	69.1	72.2	86.4	88.9	91.8	94	98.6
30	103	104	109	160	162	165	177	200	381	944
40	1250									

SUMMARY STATISTICS for Barium								
n	41							
Min	6.25							
Max	1250							
Range	1243.8							
Mean	128.39							
Median	64.5							
Variance	55073							
StdDev	234.68							
Std Error	36.65							
Skewness	3.968							
Interquartile Range	69.8							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
6.25	13.72	19.88	33.7	64.5	103.5	195.4	887.7	1250

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Barium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.779	3.05	Yes

The test statistic 4.779 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Barium

1	1250

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.4913
Shapiro-Wilk 5% Critical Value	0.94

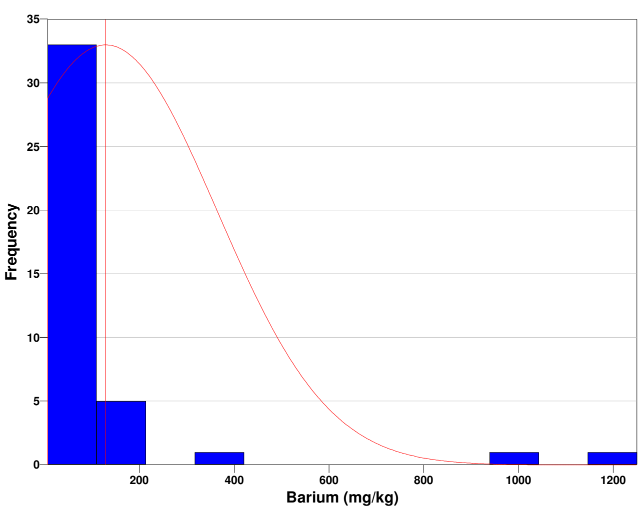
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

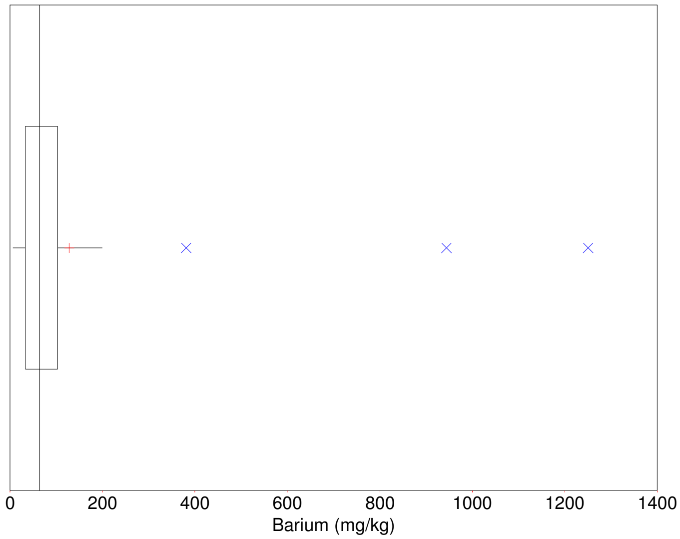
Data Plots for Barium
Graphical displays of the data are shown below.

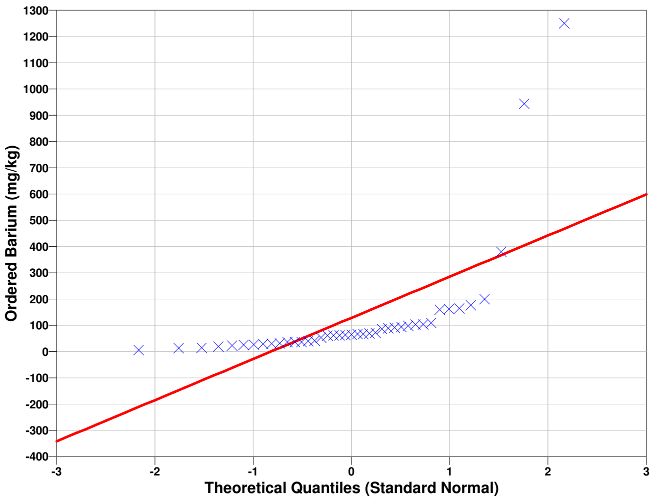
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Barium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.4558
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	190.1

95% Non-Parametric (Chebyshev) UCL	288.1

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (288.1) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-5.501	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
38	26	Reject

Data Analysis for Beryllium
The following data points were entered by the user for analysis.

Beryllium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0105	0.011	0.012	0.023	0.041	0.049	0.056	0.056	0.0706	0.074
10	0.075	0.078	0.087	0.092	0.094	0.1	0.11	0.12	0.13	0.13
20	0.14	0.15	0.16	0.19	0.2	0.2	0.2	0.22	0.22	0.23
30	0.24	0.27	0.31	0.34	0.37	0.38	0.46	0.49	0.52	0.52
40	0.89									

SUMMARY STATISTICS for Beryllium	
n	41
Min	0.0105
Max	0.89

Range				0.8795				
Mean				0.19803				
Median				0.14				
Variance				0.03256				
StdDev				0.18044				
Std Error				0.028181				
Skewness				1.8101				
Interquartile Range				0.1805				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0105	0.0111	0.0266	0.0745	0.14	0.255	0.484	0.52	0.89

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Beryllium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.835	3.05	Yes

The test statistic 3.835 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Beryllium	
1	0.89

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8787
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

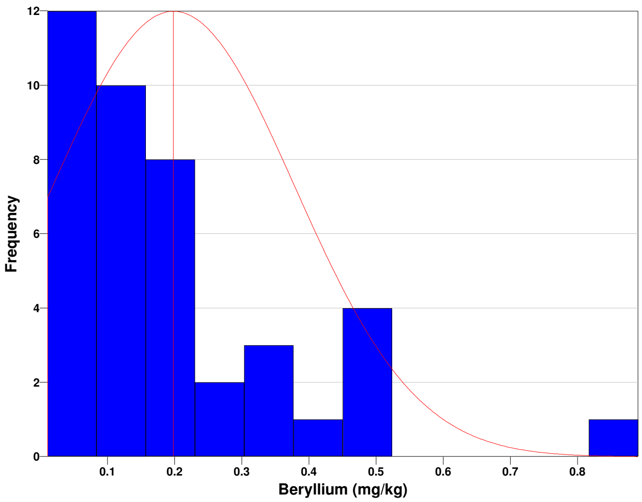
Data Plots for Beryllium
Graphical displays of the data are shown below.

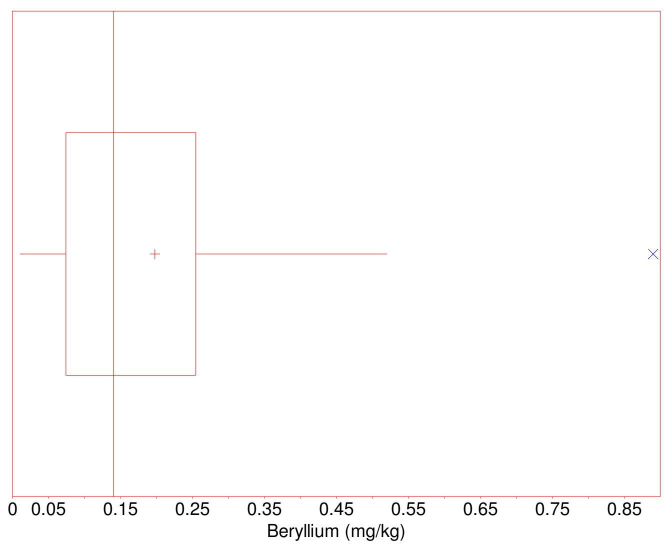
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

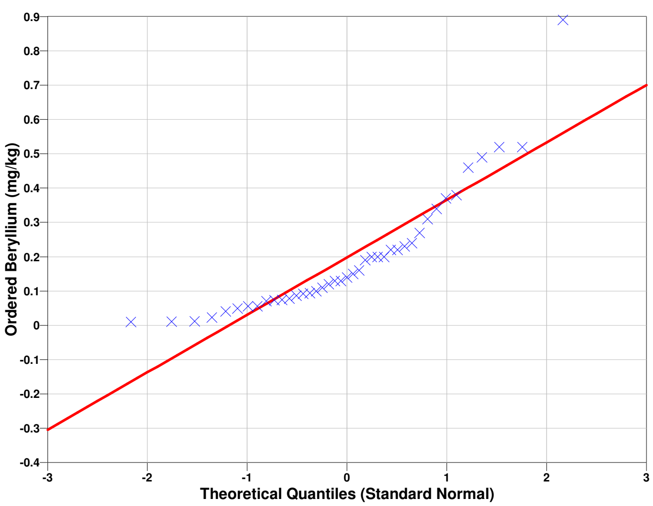
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Beryllium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8343
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.2455
95% Non-Parametric (Chebyshev) UCL	0.3209

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.3209) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-347.83	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Cadmium
The following data points were entered by the user for analysis.

Cadmium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0405	0.0418	0.043	0.045	0.046	0.047	0.0485	0.049	0.0495	0.05
10	0.05	0.0525	0.0525	0.0525	0.055	0.055	0.055	0.055	0.055	0.055
20	0.055	0.055	0.055	0.0575	0.0575	0.0575	0.06	0.06	0.06	0.06
30	0.06	0.065	0.065	0.07	0.12	0.14	0.17	0.19	0.23	0.56
40	1.1									

SUMMARY STATISTICS for Cadmium	
n	41
Min	0.0405
Max	1.1
Range	1.0595
Mean	0.10598
Median	0.055
Variance	0.032888
StdDev	0.18135
Std Error	0.028322
Skewness	4.7306
Interquartile Range	0.0125

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0405	0.04192	0.0452	0.05	0.055	0.0625	0.186	0.527	1.1

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Cadmium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.481	3.05	Yes

The test statistic 5.481 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Cadmium

1	1.1

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.4281
Shapiro-Wilk 5% Critical Value	0.94

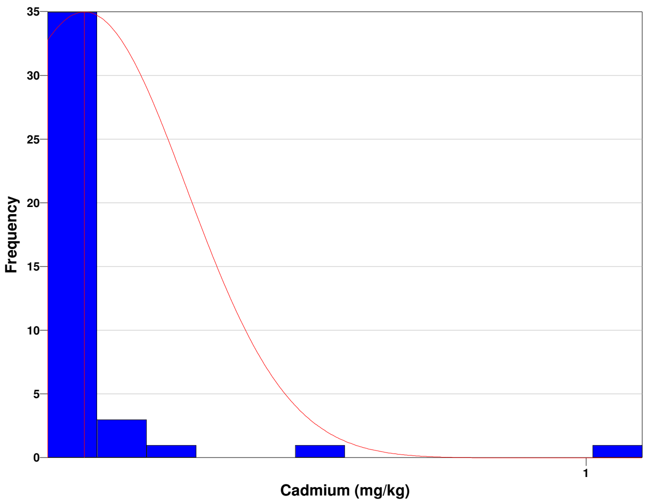
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

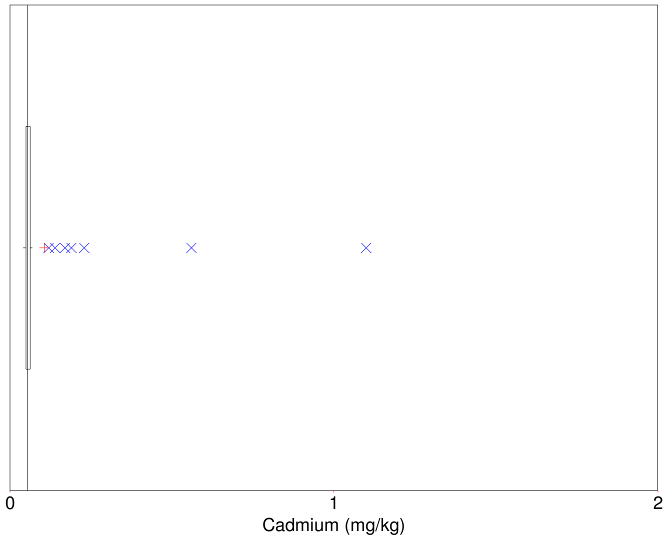
Data Plots for Cadmium
Graphical displays of the data are shown below.

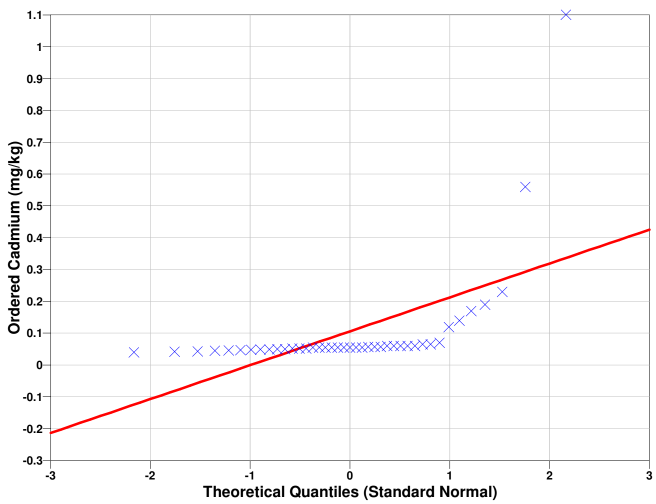
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Cadmium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.3646
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.1537

95% Non-Parametric (Chebyshev) UCL	0.2294

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.2294) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1126.1	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Chromium
The following data points were entered by the user for analysis.

Chromium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.505	0.77	0.9	0.92	1.1	1.4	1.45	1.6	1.71	2
10	2.3	2.8	2.8	2.9	3.6	3.6	3.7	3.8	3.9	4
20	4	4.2	4.5	4.5	4.9	5.05	5.1	5.15	6.4	6.7
30	6.9	7.4	7.8	8.3	8.9	9	9.6	10.4	11.3	13.3
40	14.9									

SUMMARY STATISTICS for Chromium	
n	41
Min	0.505
Max	14.9

Range				14.395				
Mean				4.977				
Median				4				
Variance				12.44				
StdDev				3.527				
Std Error				0.55082				
Skewness				1.0011				
Interquartile Range				5				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.505	0.783	0.956	2.15	4	7.15	10.24	13.1	14.9

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Chromium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.813	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9271
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

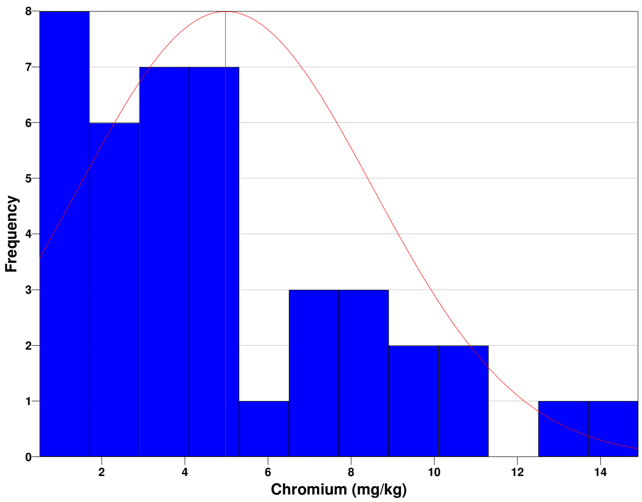
Data Plots for Chromium
Graphical displays of the data are shown below.

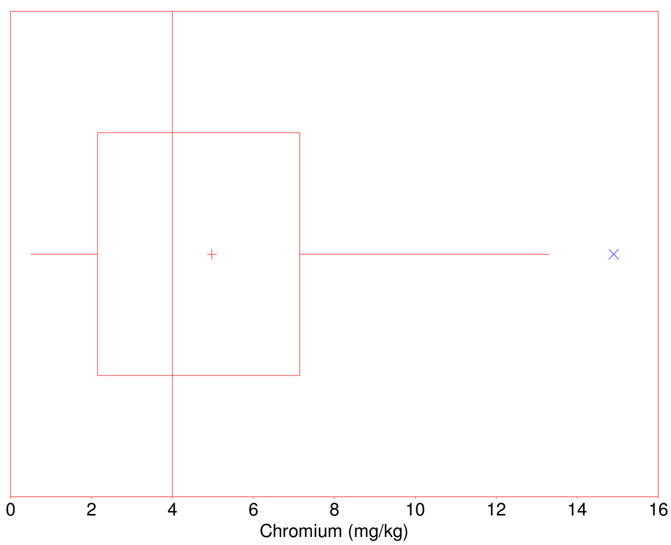
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally

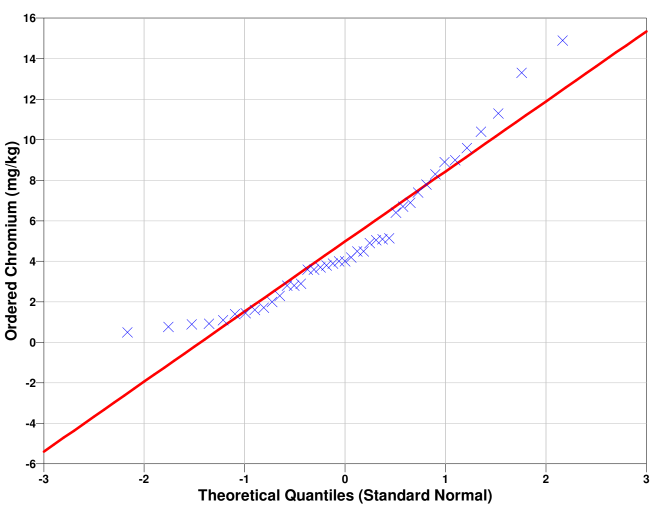
distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Chromium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was

conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9122
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	5.904
95% Non-Parametric (Chebyshev) UCL	7.378

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (7.378) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
8.3093	1.6839	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
0	26	Cannot Reject
Note: There may not be enough data to reject the null hypothesis (and conclude site is clean) with 95% confidence using the MARSSIM sign test.		

Data Analysis for Cobalt
The following data points were entered by the user for analysis.

Cobalt (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.08	0.095	0.1	0.108	0.19	0.2	0.36	0.43	0.44	0.464
10	0.47	0.53	0.61	0.62	0.71	0.74	1	1.1	1.1	1.2
20	1.3	1.3	1.3	1.3	1.3	1.45	1.45	1.5	1.55	1.6
30	1.7	1.7	1.8	2.2	2.3	2.5	2.5	2.8	3	3.3
40	4.6									

SUMMARY STATISTICS for Cobalt	
n	41
Min	0.08
Max	4.6
Range	4.52
Mean	1.2926
Median	1.3
Variance	0.99774
StdDev	0.99887
Std Error	0.156
Skewness	1.1633
Interquartile Range	1.233

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.08	0.0955	0.1244	0.467	1.3	1.7	2.74	3.27	4.6

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Cobalt			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.311	3.05	Yes

The test statistic 3.311 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Cobalt

1	4.6

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9312
Shapiro-Wilk 5% Critical Value	0.94

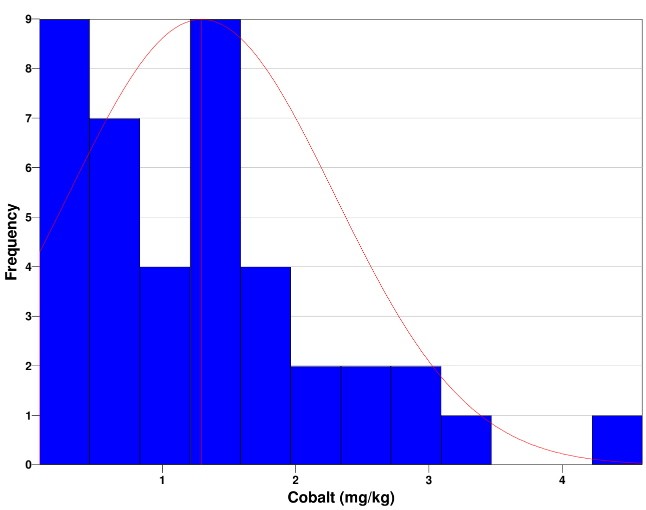
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

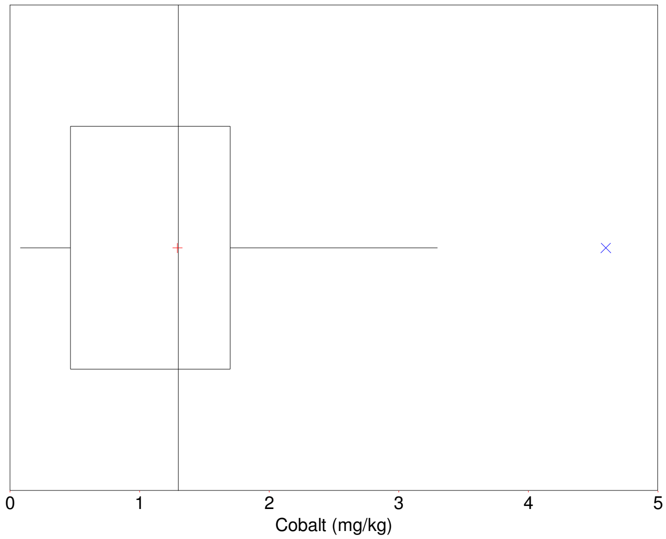
Data Plots for Cobalt
Graphical displays of the data are shown below.

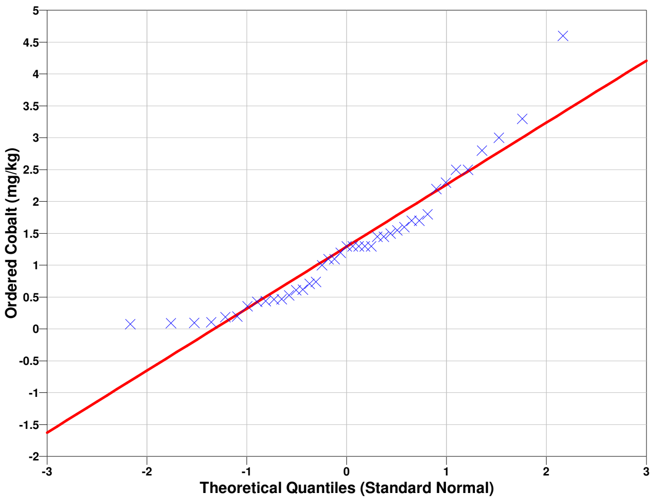
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Cobalt
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9087
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	1.555

95% Non-Parametric (Chebyshev) UCL	1.973

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (1.973) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-75.049	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Copper
The following data points were entered by the user for analysis.

Copper (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.685	0.86	0.93	0.93	0.95	0.99	1	1.01	1.1	1.4
10	1.7	2.2	2.4	2.5	2.5	2.7	2.7	3.1	3.2	3.25
20	3.3	3.3	3.4	3.55	3.6	3.6	3.7	4.2	4.5	4.7
30	4.7	4.8	5.1	5.2	5.7	6.9	8.1	9.6	10.3	10.7
40	23.5									

SUMMARY STATISTICS for Copper	
n	41
Min	0.685
Max	23.5

Range	22.815
Mean	4.1111
Median	3.3
Variance	16.062
StdDev	4.0077
Std Error	0.62589
Skewness	3.1509
Interquartile Range	3.2

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.685	0.867	0.934	1.55	3.3	4.75	9.3	10.66	23.5

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Copper			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.838	3.05	Yes

The test statistic 4.838 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Copper	
1	23.5

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8635
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

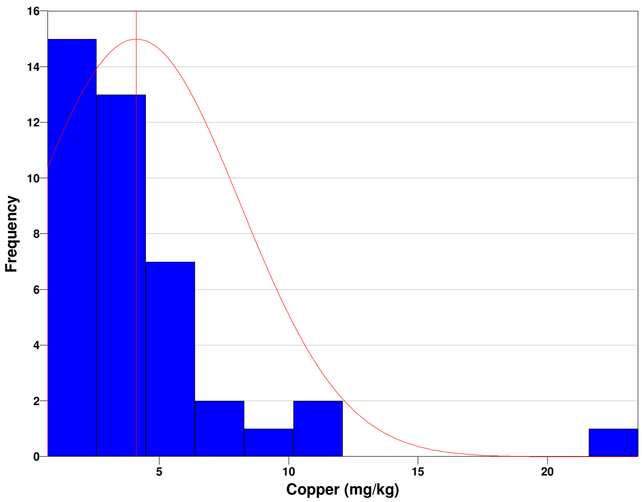
Data Plots for Copper
Graphical displays of the data are shown below.

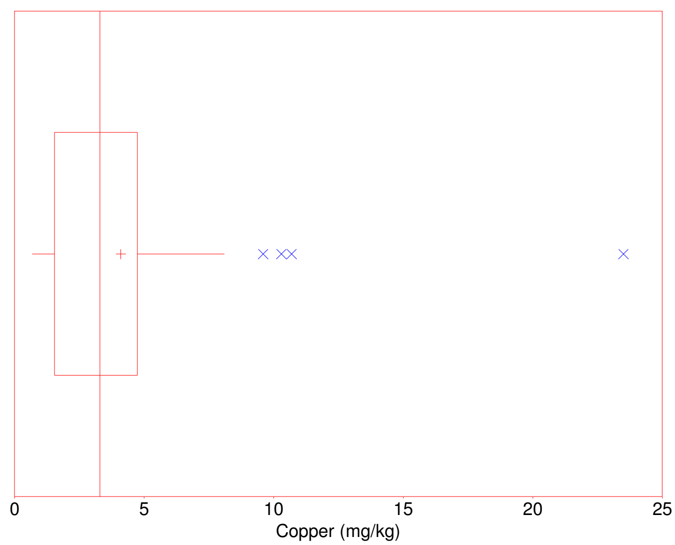
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

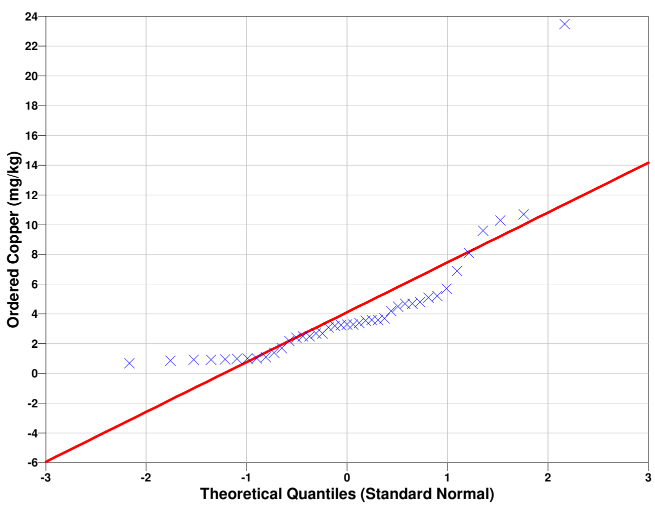
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Copper
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6979
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	5.165
95% Non-Parametric (Chebyshev) UCL	6.839

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (6.839) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-90.892	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Lead
The following data points were entered by the user for analysis.

Lead (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	2.02	2.15	2.45	2.6	3.4	3.6	3.7	3.9	4.6	4.8
10	5.1	5.4	6	6.1	6.7	6.9	6.9	7	7.2	8
20	8.3	8.9	9.2	9.8	9.9	10.4	11.6	12.7	14.8	16.1
30	17.1	17.7	18.8	18.9	19.8	20.9	22.5	23.8	55.8	80.6
40	80.7									

SUMMARY STATISTICS for Lead	
n	41
Min	2.02
Max	80.7
Range	78.68
Mean	14.313
Median	8.3
Variance	320.07
StdDev	17.891
Std Error	2.794
Skewness	2.929
Interquartile Range	12.45

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
2.02	2.18	2.76	4.95	8.3	17.4	23.54	78.12	80.7

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Lead			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.711	3.05	Yes

The test statistic 3.711 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Lead

1	80.7

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6209
Shapiro-Wilk 5% Critical Value	0.94

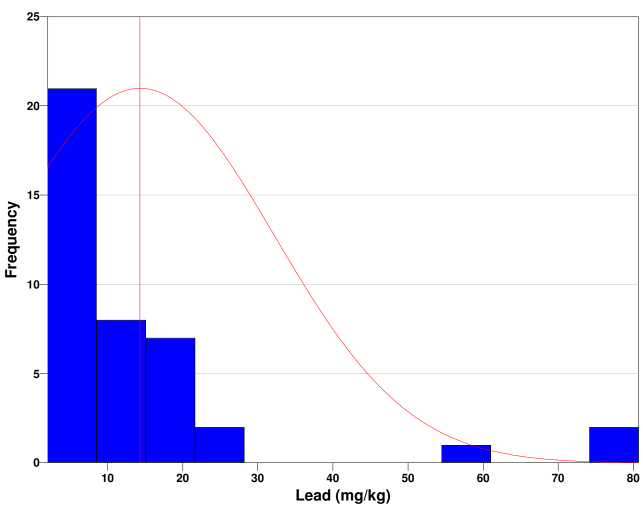
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

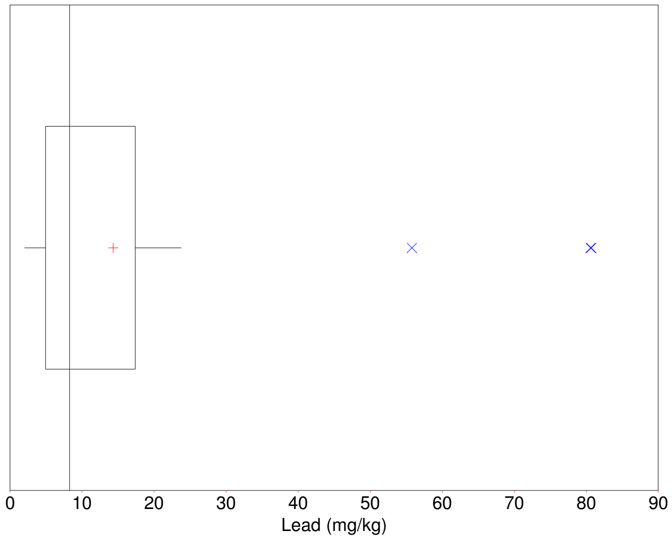
Data Plots for Lead
Graphical displays of the data are shown below.

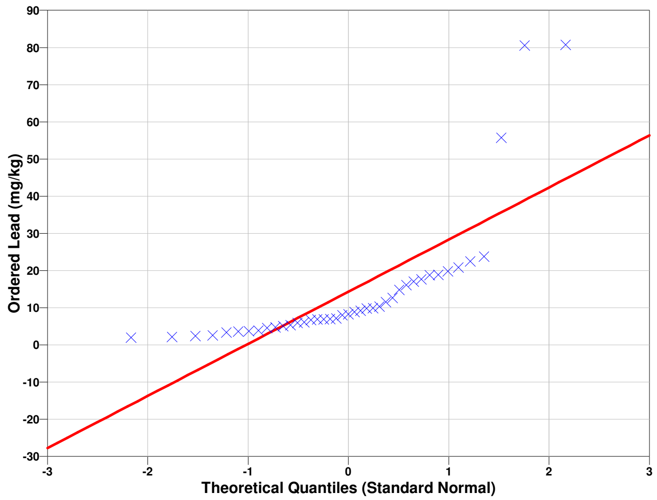
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Lead

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5993
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	19.02

95% Non-Parametric (Chebyshev) UCL	26.49

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (26.49) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-37.826	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Manganese
The following data points were entered by the user for analysis.

Manganese (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	9.3	9.3	10	11.5	15.7	17.7	21.1	21.5	26.4	27.7
10	37.3	39.6	41	42.7	43.6	47.3	49.4	49.4	65.6	66.4
20	69.4	73.6	77	77.5	80.5	92	102	102	104	106
30	110	114	121	141	143	144	146	155	191	207
40	210									

SUMMARY STATISTICS for Manganese	
n	41
Min	9.3
Max	210

Range	200.7
Mean	78.5
Median	69.4
Variance	3110.7
StdDev	55.773
Std Error	8.7103
Skewness	0.73144
Interquartile Range	79.5

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
9.3	9.37	12.34	32.5	69.4	112	153.2	205.4	210

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Manganese			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.358	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9278
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

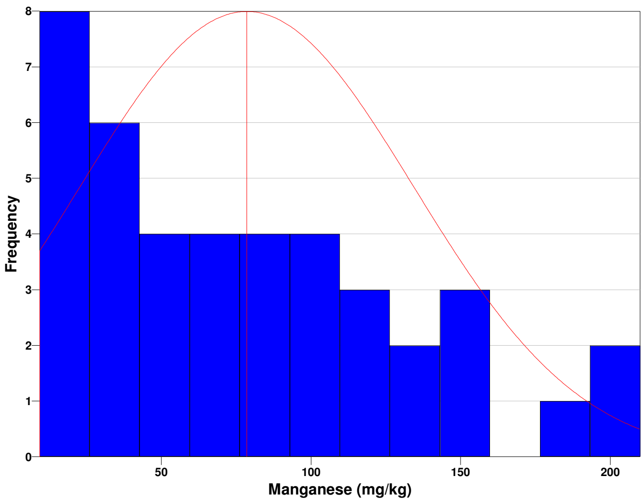
Data Plots for Manganese
Graphical displays of the data are shown below.

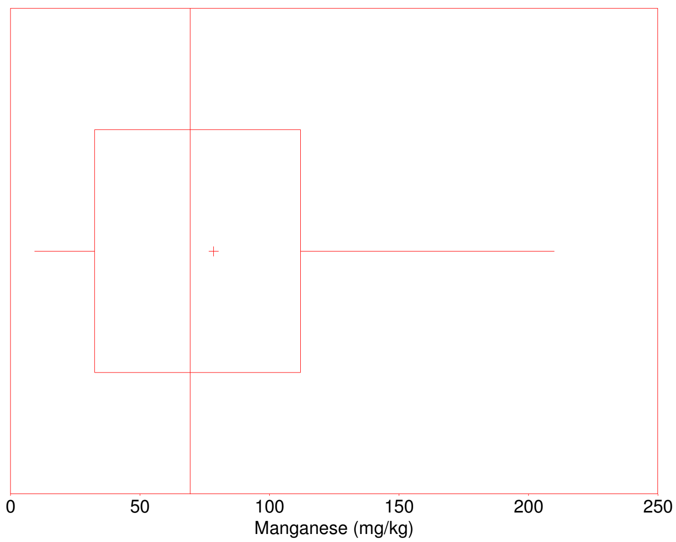
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally

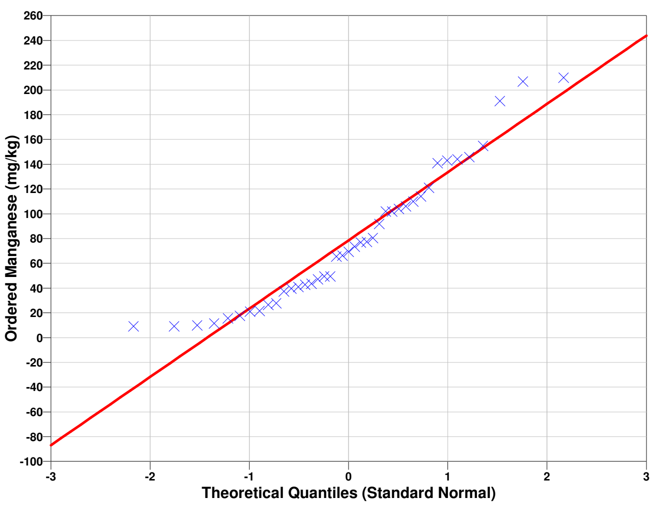
distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Manganese

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was

conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9178
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	93.17
95% Non-Parametric (Chebyshev) UCL	116.5

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (116.5) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-48.391	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Mercury
The following data points were entered by the user for analysis.

Mercury (mg/kg)

Rank	1	2	3	4	5	6	7	8	9	10
0	0.000385	0.0013	0.0014	0.0014	0.0031	0.0037	0.0047	0.00535	0.0054	0.0054
10	0.0065	0.0069	0.007	0.007	0.0072	0.0073	0.0076	0.0079	0.0082	0.0083
20	0.0088	0.0093	0.0095	0.011	0.012	0.013	0.013	0.013	0.014	0.016
30	0.016	0.019	0.0215	0.024	0.024	0.026	0.034	0.034	0.049	0.079
40	0.74									

SUMMARY STATISTICS for Mercury	
n	41
Min	0.000385
Max	0.74
Range	0.73962
Mean	0.031515
Median	0.0088
Variance	0.013073
StdDev	0.11434
Std Error	0.017856
Skewness	6.2472
Interquartile Range	0.01155

Percentiles								
1%	5%	10%	25%	50%	75%	90%	95%	99%
0.000385	0.00131	0.00174	0.00595	0.0088	0.0175	0.034	0.076	0.74

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Mercury			
k	Test Statistic R_k	5% Critical Value C_k	Significant?
1	6.197	3.05	Yes

The test statistic 6.197 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Mercury	
1	0.74

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the

suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7171
Shapiro-Wilk 5% Critical Value	0.94

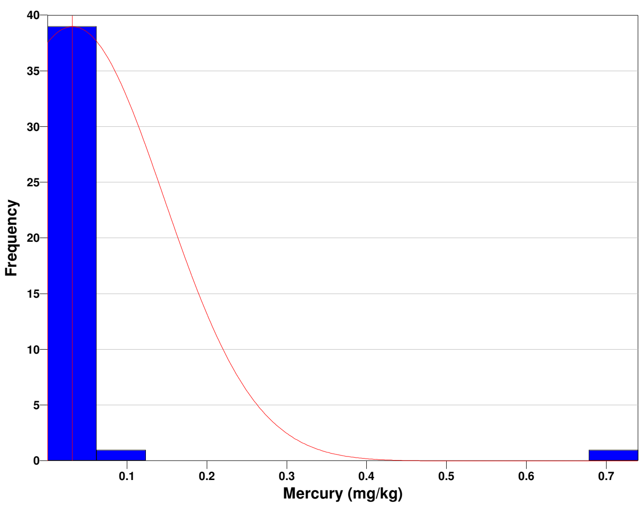
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

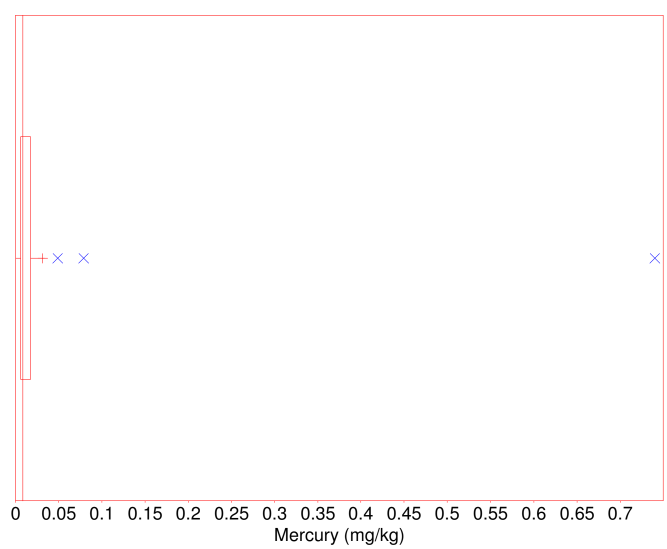
Data Plots for Mercury
Graphical displays of the data are shown below.

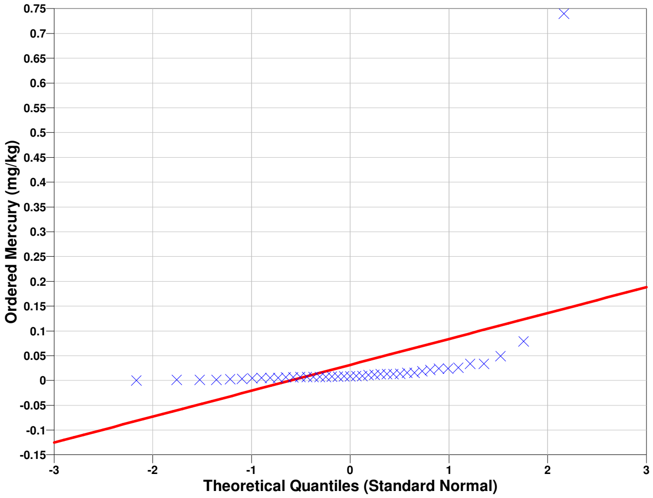
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Mercury
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.2381
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.06158
95% Non-Parametric (Chebyshev) UCL	0.1093

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.1093) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-3.8353	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
40	26	Reject

Data Analysis for Nickel
The following data points were entered by the user for analysis.

Nickel (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0775	0.26	0.27	0.29	0.35	0.48	0.56	0.76	0.81	1
10	1.1	1.2	1.2	1.3	1.3	1.5	1.7	1.8	1.9	2
20	2.1	2.2	2.2	2.4	2.5	2.7	2.95	3.05	3.3	3.4
30	3.4	3.5	4.1	4.2	4.3	4.45	5.1	5.2	5.3	8.6
40	9.3									

SUMMARY STATISTICS for Nickel								
n	41							
Min	0.0775							
Max	9.3							
Range	9.2225							
Mean	2.5392							
Median	2.1							
Variance	4.3557							
StdDev	2.087							
Std Error	0.32594							
Skewness	1.4641							
Interquartile Range	2.4							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0775	0.261	0.302	1.05	2.1	3.45	5.18	8.27	9.3

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Nickel			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.239	3.05	Yes

The test statistic 3.239 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Nickel	
1	9.3

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9125
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

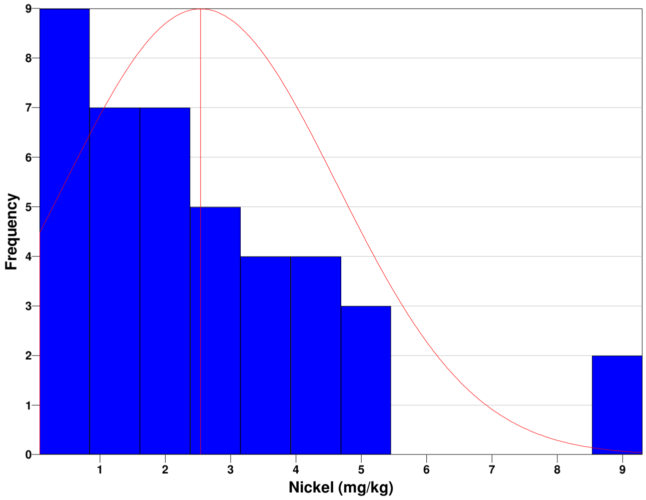
Data Plots for Nickel
Graphical displays of the data are shown below.

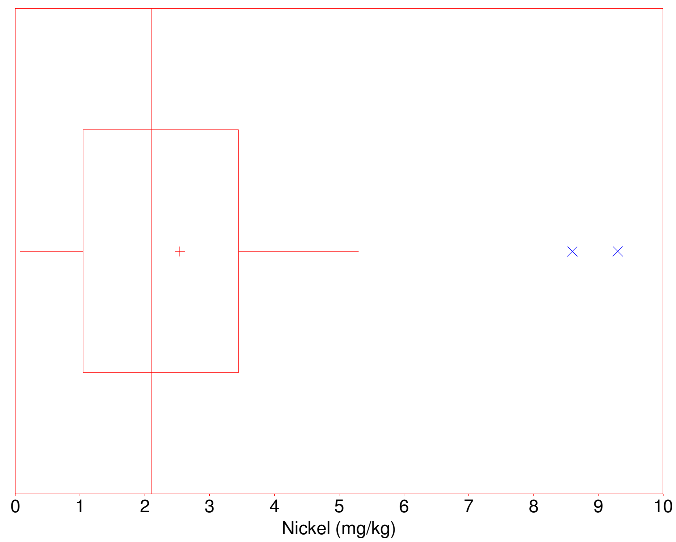
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

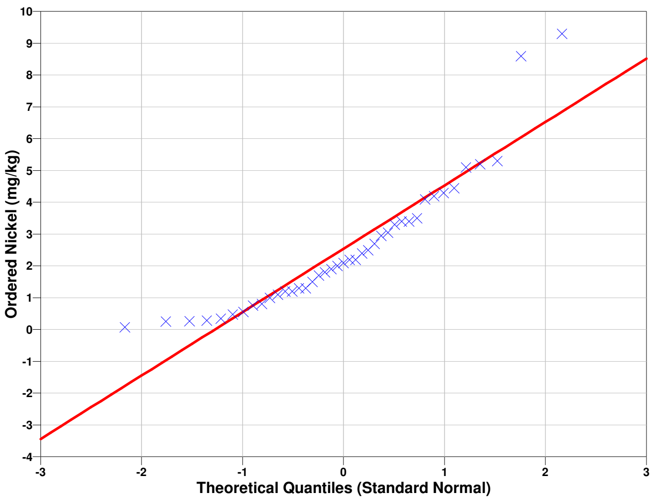
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the

Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Nickel

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8731
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	3.088
95% Non-Parametric (Chebyshev) UCL	3.96

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (3.96) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-84.251	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Toluene
The following data points were entered by the user for analysis.

Toluene (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00065	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.00075	0.00075
10	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.000775	0.0008
20	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
30	0.0008	0.0008	0.0008	0.00085	0.00085	0.0009	0.0011	0.0014	0.0015	0.0039
40	0.0044									

SUMMARY STATISTICS for Toluene	
n	41

Min				0.00065				
Max				0.0044				
Range				0.00375				
Mean				0.00097378				
Median				0.0008				
Variance				5.6012e-007				
StdDev				0.00074841				
Std Error				0.00011688				
Skewness				4.0831				
Interquartile Range				5e-005				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00065	0.0007	0.0007	0.00075	0.0008	0.0008	0.00134	0.00366	0.0044

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Toluene			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.578	3.05	Yes

The test statistic 4.578 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Toluene	
1	0.0044

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.3454
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

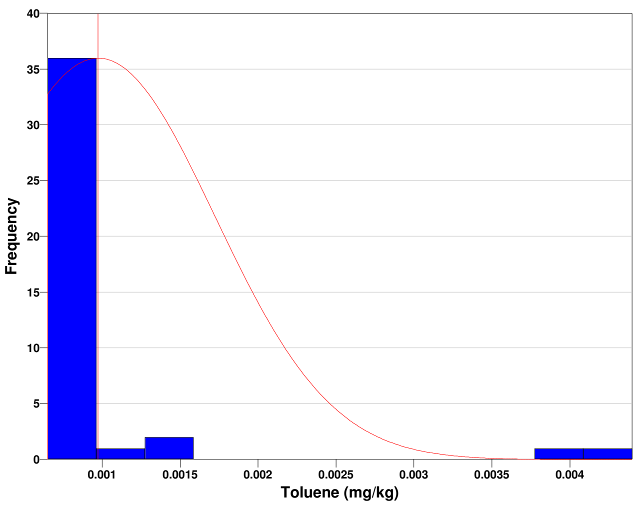
Data Plots for Toluene

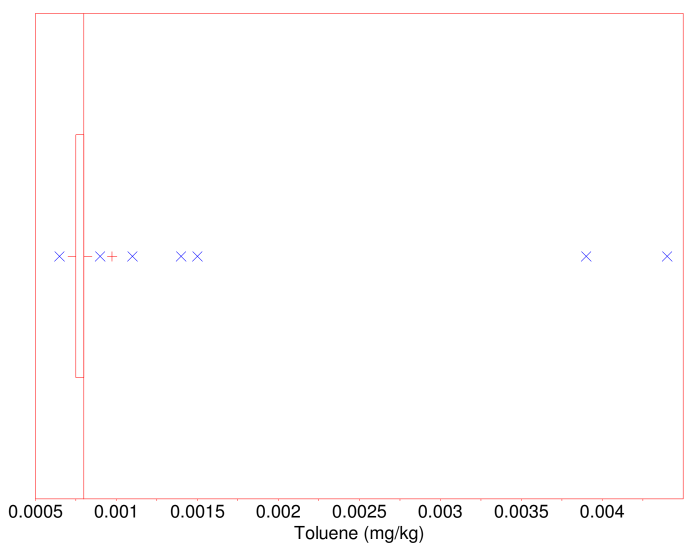
Graphical displays of the data are shown below.

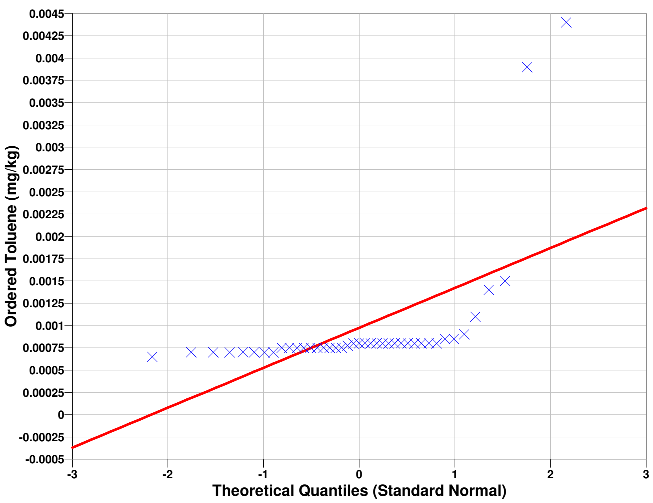
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Toluene
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.3684
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.001171
95% Non-Parametric (Chebyshev) UCL	0.001483

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.001483) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.7111e+006	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**

41	26	Reject

Data Analysis for Vanadium
The following data points were entered by the user for analysis.

Vanadium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.985	1.1	1.1	1.3	1.6	1.7	2.1	2.3	2.4	2.4
10	2.93	3.5	4.1	4.1	4.5	4.7	4.8	4.9	5.1	5.1
20	5.25	5.8	6.1	6.6	6.85	7	7.7	7.8	9.1	9.6
30	10.5	10.6	12.8	13.2	15.8	16	16.2	16.6	17.3	22.3
40	29.3									

SUMMARY STATISTICS for Vanadium								
n	41							
Min	0.985							
Max	29.3							
Range	28.315							
Mean	7.637							
Median	5.25							
Variance	40.719							
StdDev	6.3812							
Std Error	0.99657							
Skewness	1.4668							
Interquartile Range	7.885							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.985	1.1	1.36	2.665	5.25	10.55	16.52	21.8	29.3

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Vanadium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.395	3.05	Yes

The test statistic 3.395 exceeded the corresponding critical value, therefore that test is significant and we conclude that the

most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Vanadium	
1	29.3

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8818
Shapiro-Wilk 5% Critical Value	0.94

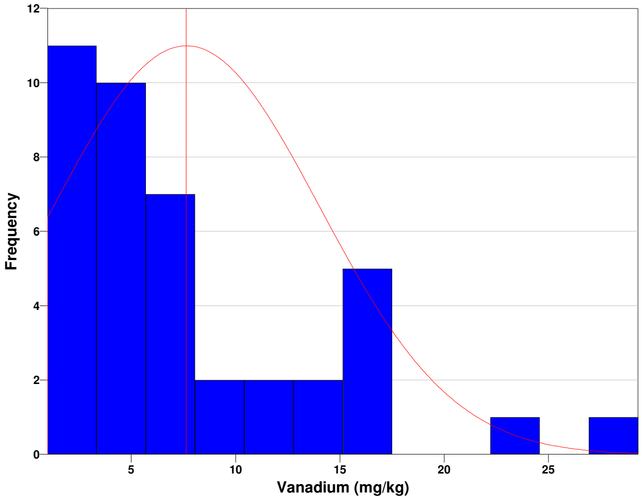
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

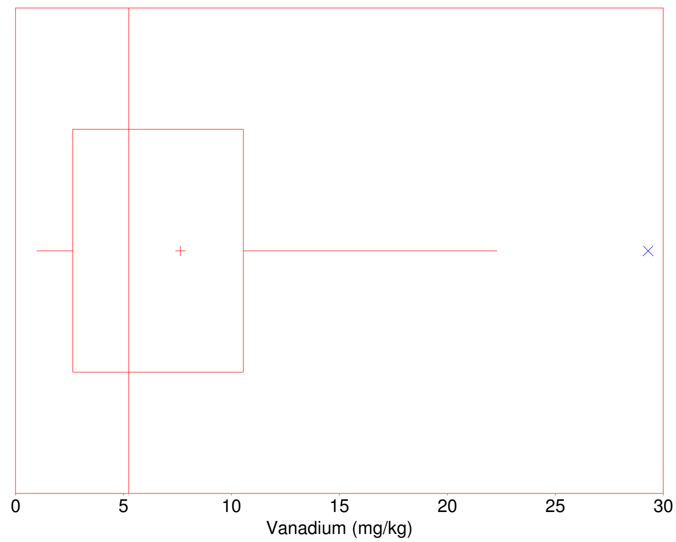
Data Plots for Vanadium
Graphical displays of the data are shown below.

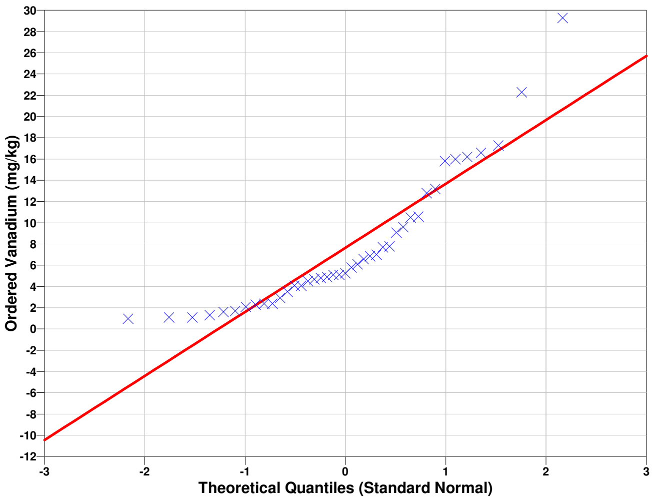
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Vanadium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8548
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	9.315

95% Non-Parametric (Chebyshev) UCL	11.98

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (11.98) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
5.6564	1.6839	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
6	26	Cannot Reject
Note: There may not be enough data to reject the null hypothesis (and conclude site is clean) with 95% confidence using the MARSSIM sign test.		

Data Analysis for Zinc
The following data points were entered by the user for analysis.

Zinc (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	3.1	6.1	8.7	10.4	10.6	11.1	12.2	16.6	17.2	19.7
10	20.1	22.2	22.8	23.6	25.2	25.9	26.1	26.2	29.4	29.8
20	30.2	31.1	31.8	35	39.5	40.2	40.7	40.7	44.1	48
30	48.5	59	59	79	80.3	85.3	92.6	129	143	156
40	232									

SUMMARY STATISTICS for Zinc

n				41				
Min				3.1				
Max				232				
Range				228.9				
Mean				46.634				
Median				30.2				
Variance				2169.2				
StdDev				46.575				
Std Error				7.2737				
Skewness				2.2859				
Interquartile Range				33.85				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
3.1	6.36	10.44	19.9	30.2	53.75	121.7	154.7	232

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Zinc			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.98	3.05	Yes

The test statistic 3.98 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Zinc	
1	232

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.799
Shapiro-Wilk 5% Critical Value	0.94

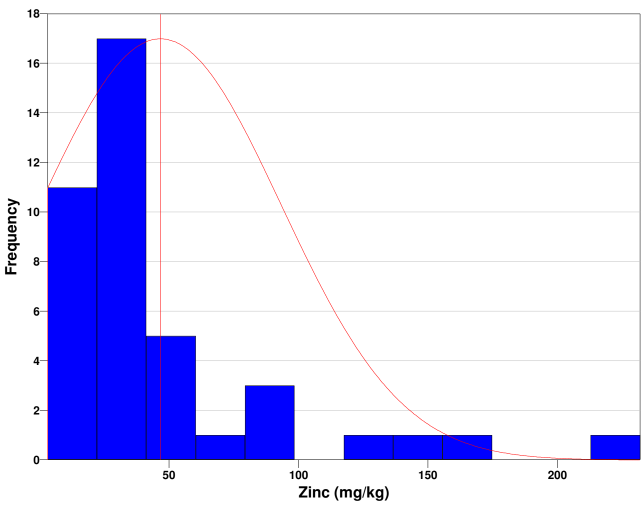
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

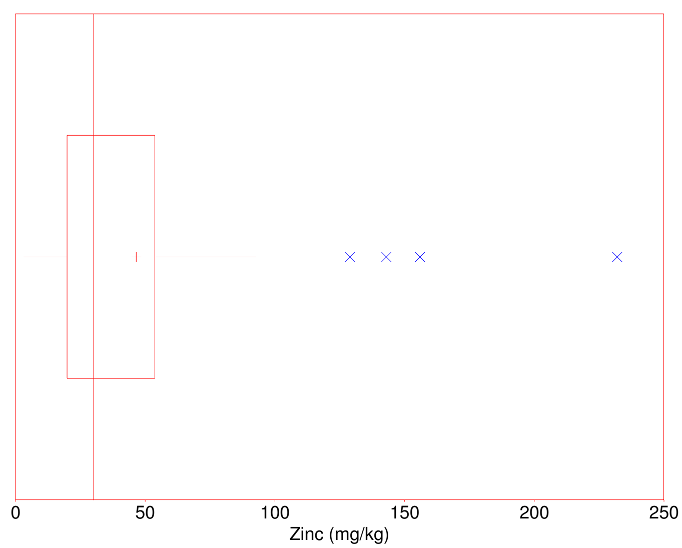
Data Plots for Zinc
Graphical displays of the data are shown below.

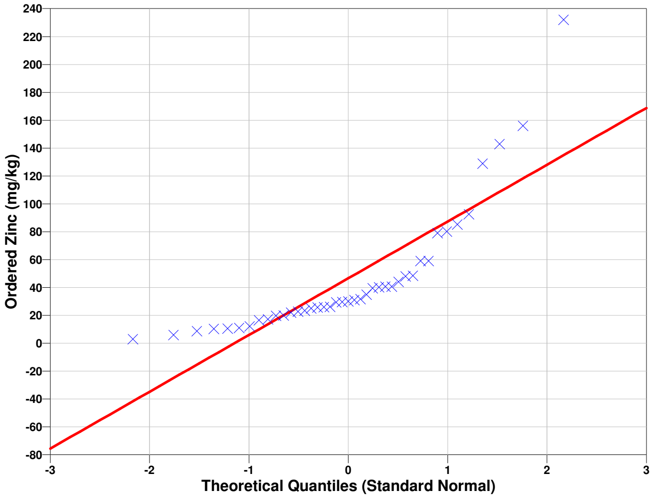
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Zinc
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7459
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	58.88
95% Non-Parametric (Chebyshev) UCL	78.34

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (78.34) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-10.086	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
37	26	Reject

This report was automatically produced* by Visual Sample Plan (VSP) software version 5.3.1.

Software and documentation available at http://dqo.pnl.gov/vsp

* - The report contents may have been modified or reformatted by end-user of software.

Appendix C

VSP Reports of Calculated Minimum Sample Quantity
Report 4
Area of Concern – 1
Minimum Sample Quantity Calculation for Subsurface Soil using Human Health Benchmarks and Delta Method 1

Random sampling locations for comparing a mean with a fixed threshold (parametric)

Summary
This report summarizes the sampling design, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design for Chromium, the driving analyte (the analyte which required the largest number of samples). A figure that shows sampling locations in the field is also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean to a fixed threshold
Type of Sampling Design	Parametric
Sample Placement (Location) in the Field	Simple random sampling
Working (Null) Hypothesis	The mean value at the site exceeds the threshold
Formula for calculating number of sampling locations	Student's t-test
Calculated total number of samples	2665
Number of samples on map [a]	2665
Number of selected sample areas [b]	1
Specified sampling area [c]	188054.34 m^2
Total cost of sampling [d]	$1,333,500.00

[a] This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[d] Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.

Primary Sampling Objective
The primary purpose of sampling at this site is to compare a mean value of a site with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the mean value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the mean value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative hypothesis, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach
A parametric random sampling approach was used to determine the number of samples and to specify sampling locations. A parametric formula was chosen because the conceptual model and historical information (e.g., historical data from this

site or a very similar site) indicate that parametric assumptions are reasonable. These assumptions will be examined in post-sampling data analysis.

Both parametric and non-parametric approaches rely on assumptions about the population. However, non-parametric approaches typically require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than the number of samples required by non-parametric approaches.

Locating the sample points randomly provides data that are separated by many distances, whereas systematic samples are all equidistant apart. Therefore, random sampling provides more information about the spatial structure of the potential contamination than systematic sampling does. As with systematic sampling, random sampling also provides information regarding the mean value, but there is the possibility that areas of the site will not be represented with the same frequency as if uniform grid sampling were performed.

Number of Total Samples: Calculation Equation and Inputs
The equation used to calculate the number of samples is based on a Student's t-test. For this site, the null hypothesis is rejected in favor of the alternative hypothesis if the sample mean is sufficiently smaller than the threshold. The number of samples to collect is calculated so that 1) there will be a high probability ($1-\beta$) of rejecting the null hypothesis if the alternative hypothesis is true and 2) a low probability (α) of rejecting the null hypothesis if the null hypothesis is true.

The formula used to calculate the number of samples is:

$$n = \frac{S^2}{\Delta^2}\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2 + 0.5Z_{1-\alpha}^2$$

where
n is the number of samples,
S is the estimated standard deviation of the measured values including analytical error,
Δ is the width of the gray region,
α is the acceptable probability of incorrectly concluding the site mean is less than the threshold,
β is the acceptable probability of incorrectly concluding the site mean exceeds the threshold,
$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is $1-\alpha$,
$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is $1-\beta$.

The values of these inputs that result in the calculated number of sampling locations are:

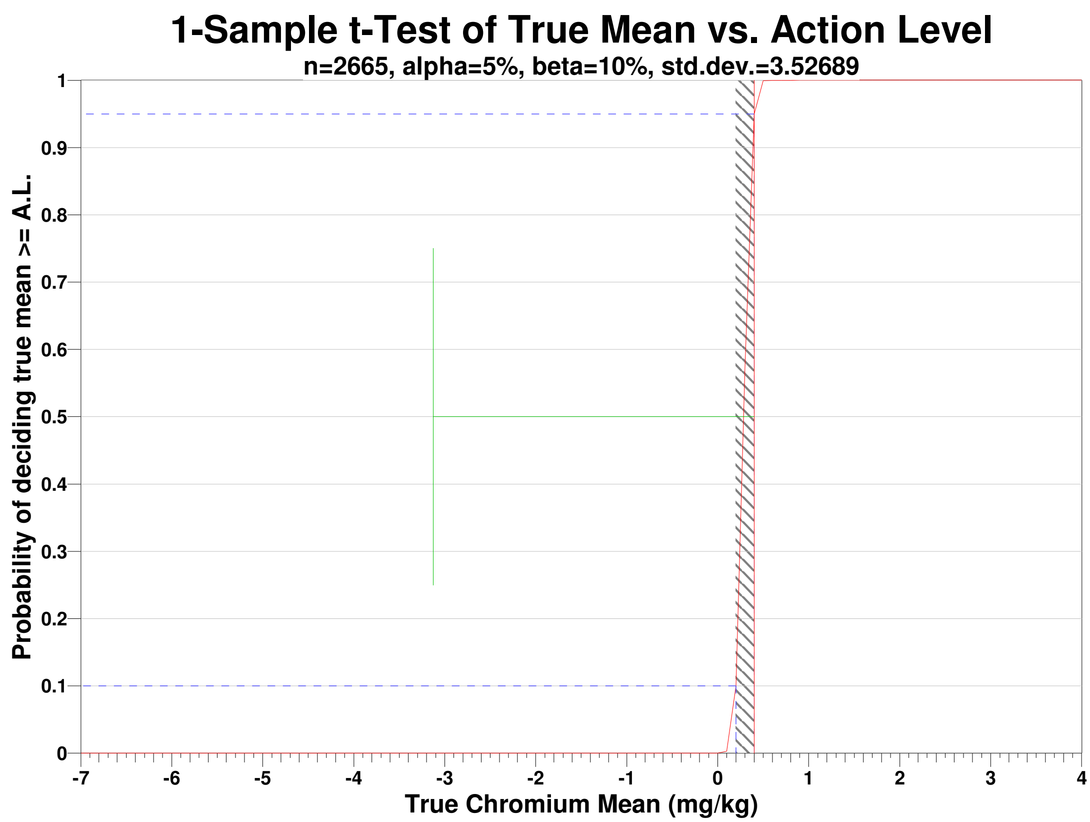
Analyte	n	Parameter					
		S	**Δ**	**α**	**β**	**$Z_{1-\alpha}$** [a]	**$Z_{1-\beta}$** [b]
New Location	2	0.1 mg/kg	10 mg/kg	0.05	0.1	1.64485	1.28155
Arsenic	2	0.899292 mg/kg	9 mg/kg	0.05	0.1	1.64485	1.28155
Barium	19	234.679 mg/kg	165 mg/kg	0.05	0.1	1.64485	1.28155
Beryllium	2	0.180444 mg/kg	5 mg/kg	0.05	0.1	1.64485	1.28155
Cadmium	2	0.181351 mg/kg	16 mg/kg	0.05	0.1	1.64485	1.28155
Chromium	2665	3.52689 mg/kg	0.2 mg/kg	0.05	0.1	1.64485	1.28155
Cobalt	2	0.998894 mg/kg	6.5 mg/kg	0.05	0.1	1.64485	1.28155
Copper	2	4.00774 mg/kg	30.5 mg/kg	0.05	0.1	1.64485	1.28155
Lead	3	17.8896 mg/kg	60 mg/kg	0.05	0.1	1.64485	1.28155
Manganese	2	55.7772 mg/kg	250 mg/kg	0.05	0.1	1.64485	1.28155
Mercury	47	0.114336 mg/kg	0.05 mg/kg	0.05	0.1	1.64485	1.28155
Nickel	2	2.08703 mg/kg	15 mg/kg	0.05	0.1	1.64485	1.28155
Toluene	2	0.000748414 mg/kg	100 mg/kg	0.05	0.1	1.64485	1.28155
Vanadium	350	6.37936 mg/kg	1 mg/kg	0.05	0.1	1.64485	1.28155

Zinc	7	46.5764 mg/kg	60 mg/kg	0.05	0.1	1.64485	1.28155

[a] This value is automatically calculated by VSP based upon the user defined value of α.
[b] This value is automatically calculated by VSP based upon the user defined value of β.

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000) for Chromium, the driving analyte. It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true mean values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at 1-α on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at 1-α. If any of the inputs change, the number of samples that result in the correct curve changes.



Statistical Assumptions
The assumptions associated with the formulas for computing the number of samples are:
1. the sample mean is normally distributed (this happens if the data are roughly symmetric or the sample size is more than 30; for extremely skewed data sets, additional samples may be required for the sample mean to be normally distributed),
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected randomly.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the sample locations were selected using a random process.

Sensitivity Analysis
The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that μ > action level and alpha (%), probability

of mistakenly concluding that μ < action level. The following table shows the results of this analysis.

Number of Samples							
AL=120		α=5		α=10		α=15	
		s=93.1528	s=46.5764	s=93.1528	s=46.5764	s=93.1528	s=46.5764
LBGR=90	β=5	58693007	14673253	46445193	11611299	38990470	9747618
	β=10	46445194	11611300	35629032	8907259	29140237	7285060
	β=15	38990470	9747619	29140238	7285060	23303151	5825788
LBGR=80	β=5	14673253	3668315	11611299	2902826	9747618	2436905
	β=10	11611300	2902826	8907259	2226816	7285060	1821266
	β=15	9747619	2436906	7285060	1821266	5825788	1456448
LBGR=70	β=5	6521447	1630363	5160578	1290146	4332275	1083070
	β=10	5160579	1290146	3958783	989697	3237805	809452
	β=15	4332276	1083070	3237805	809452	2589240	647311

s = Standard Deviation
LBGR = Lower Bound of Gray Region (% of Action Level)
β = Beta (%), Probability of mistakenly concluding that μ > action level
α = Alpha (%), Probability of mistakenly concluding that μ < action level
AL = Action Level (Threshold)

Cost of Sampling
The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that are based on the number of samples collected and measured. Based on the numbers of samples determined above, the estimated total cost of sampling and analysis at this site is $1,333,500.00, which averages out to a per sample cost of $500.38. The following table summarizes the inputs and resulting cost estimates.

COST INFORMATION			
Cost Details	**Per Analysis**	**Per Sample**	**2665 Samples**
Field collection costs		$100.00	$266,500.00
Analytical costs	$400.00	$400.00	$1,066,000.00
Sum of Field & Analytical costs		**$500.00**	**$1,332,500.00**
Fixed planning and validation costs			$1,000.00
Total cost			**$1,333,500.00**

Data Analysis for New Location

SUMMARY STATISTICS for New Location	
n	2624
Min	0
Max	0
Range	0
Mean	0
Median	0
Variance	0

StdDev				0				
Std Error				0				
Skewness				-1.#IND				
Interquartile Range				0				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0	0	0	0	0	0	0	0	0

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for New Location			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	0	-1	Yes

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Lilliefors test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Lilliefors Test Statistic	1.061e+292
Lilliefors 5% Critical Value	1.376e-313

The calculated Lilliefors test statistic exceeds the 5% Lilliefors critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

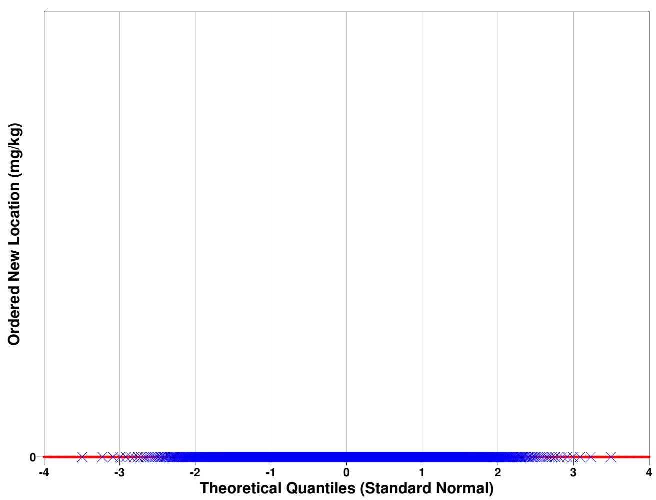
Data Plots for New Location
Graphical displays of the data are shown below.

The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends

to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.



For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for New Location

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Lilliefors test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Lilliefors Test Statistic	0
Lilliefors 5% Critical Value	0.0173

The calculated Lilliefors test statistic is less than the 5% Lilliefors critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0
95% Non-Parametric (Chebyshev) UCL	0

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=2624 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=2623 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.#IND	1.6454	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Data Analysis for Arsenic
The following data points were entered by the user for analysis.

Arsenic (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.09	0.11	0.12	0.22	0.23	0.278	0.29	0.305	0.31	0.35
10	0.51	0.53	0.57	0.58	0.66	0.72	0.83	0.86	0.93	1.04
20	1.1	1.2	1.3	1.3	1.4	1.45	1.5	1.6	1.7	1.8
30	2	2	2	2.2	2.4	2.5	2.6	2.6	2.8	3
40	3.1									

SUMMARY STATISTICS for Arsenic	
n	41

Min	0.09
Max	3.1
Range	3.01
Mean	1.2459
Median	1.1
Variance	0.80868
StdDev	0.89926
Std Error	0.14044
Skewness	0.50174
Interquartile Range	1.57

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.09	0.111	0.222	0.43	1.1	2	2.6	2.98	3.1

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Arsenic			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.062	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.92
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

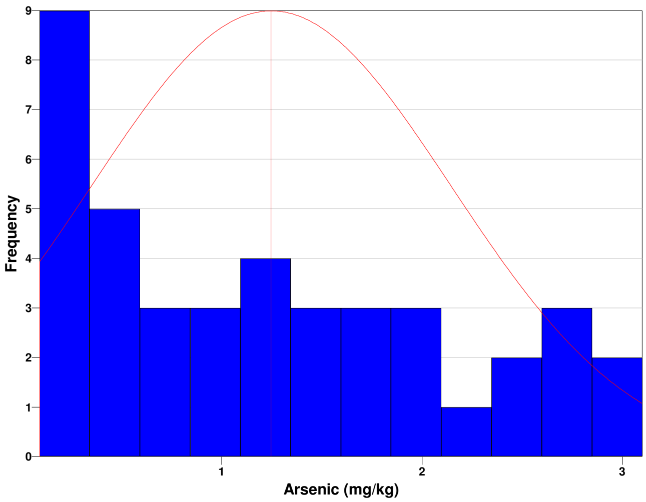
Data Plots for Arsenic
Graphical displays of the data are shown below.

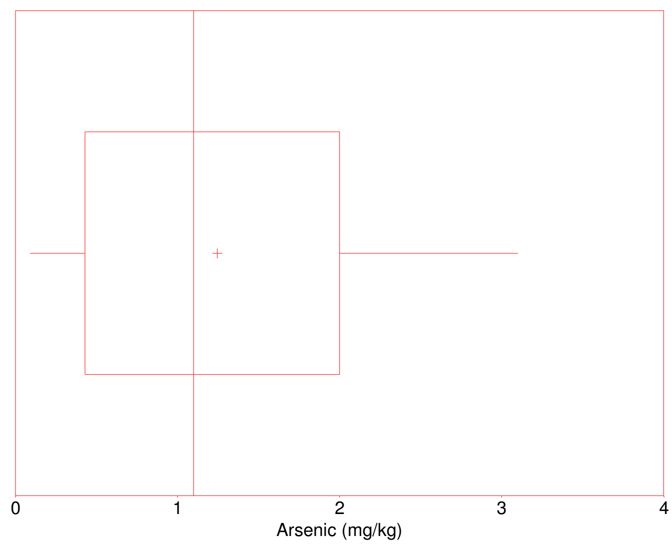
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each

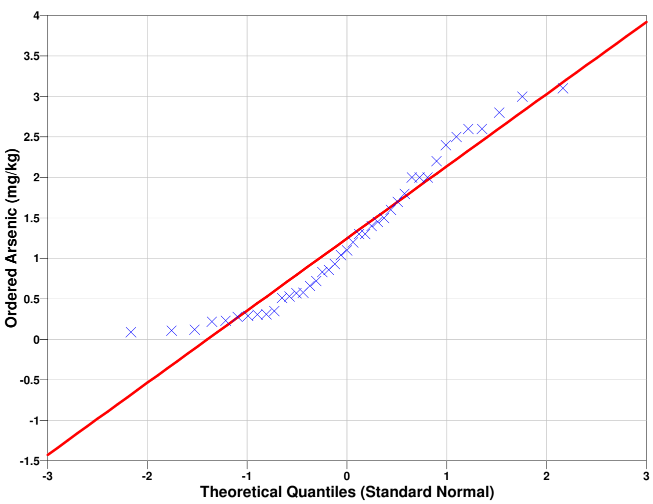
bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Arsenic
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.918
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	1.482
95% Non-Parametric (Chebyshev) UCL	1.858

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (1.858) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-119.3	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Barium
The following data points were entered by the user for analysis.

Barium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	6.25	13.7	13.9	19	23.4	25.9	26.9	28.4	30.2	31.4
10	36	36.1	36.7	39.9	41.4	53.5	60.3	61.5	61.7	63.5
20	64.5	66.6	67.1	69.1	72.2	86.4	88.9	91.8	94	98.6
30	103	104	109	160	162	165	177	200	381	944
40	1250									

SUMMARY STATISTICS for Barium	
n	41
Min	6.25
Max	1250
Range	1243.8
Mean	128.39
Median	64.5
Variance	55073
StdDev	234.68
Std Error	36.65
Skewness	3.968
Interquartile Range	69.8

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
6.25	13.72	19.88	33.7	64.5	103.5	195.4	887.7	1250

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Barium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.779	3.05	Yes

The test statistic 4.779 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Barium

1	1250

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.4913
Shapiro-Wilk 5% Critical Value	0.94

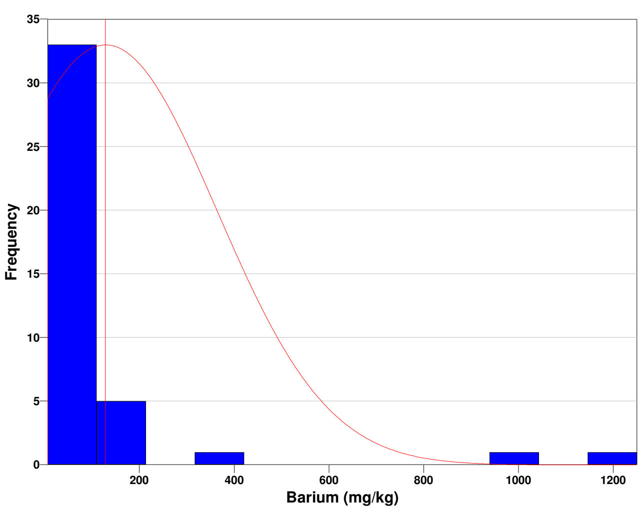
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

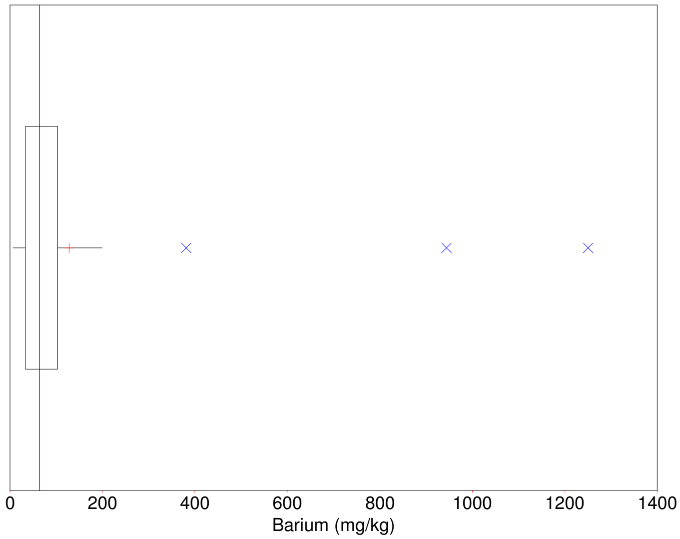
Data Plots for Barium
Graphical displays of the data are shown below.

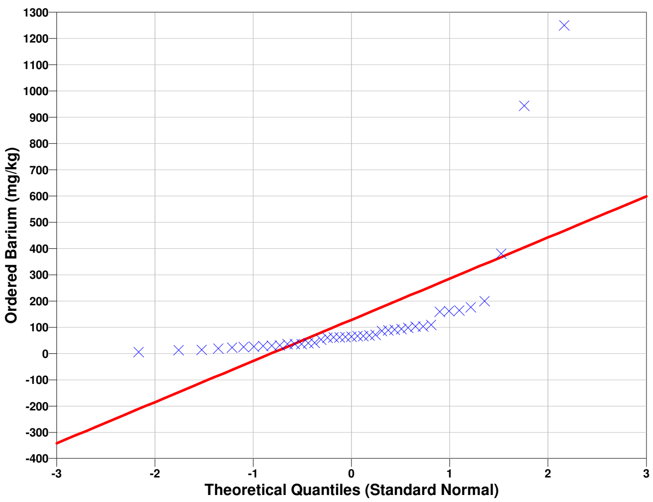
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Barium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.4558
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	190.1

95% Non-Parametric (Chebyshev) UCL	288.1

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (288.1) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-5.501	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
38	26	Reject

Data Analysis for Beryllium
The following data points were entered by the user for analysis.

Beryllium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0105	0.011	0.012	0.023	0.041	0.049	0.056	0.056	0.0706	0.074
10	0.075	0.078	0.087	0.092	0.094	0.1	0.11	0.12	0.13	0.13
20	0.14	0.15	0.16	0.19	0.2	0.2	0.2	0.22	0.22	0.23
30	0.24	0.27	0.31	0.34	0.37	0.38	0.46	0.49	0.52	0.52
40	0.89									

SUMMARY STATISTICS for Beryllium	
n	41
Min	0.0105
Max	0.89

Range				0.8795				
Mean				0.19803				
Median				0.14				
Variance				0.03256				
StdDev				0.18044				
Std Error				0.028181				
Skewness				1.8101				
Interquartile Range				0.1805				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0105	0.0111	0.0266	0.0745	0.14	0.255	0.484	0.52	0.89

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Beryllium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.835	3.05	Yes

The test statistic 3.835 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Beryllium	
1	0.89

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8787
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

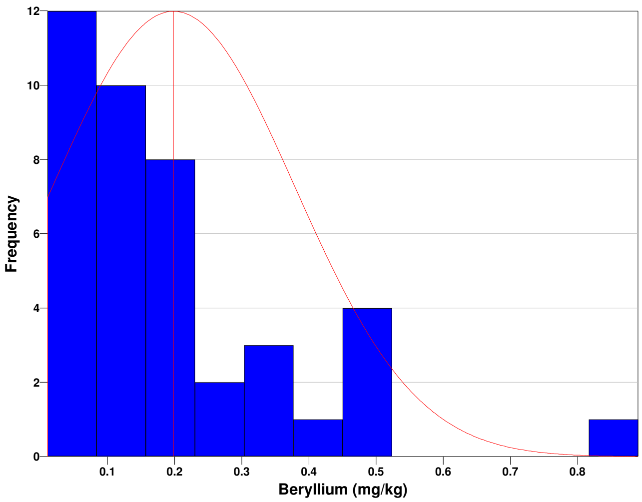
Data Plots for Beryllium
Graphical displays of the data are shown below.

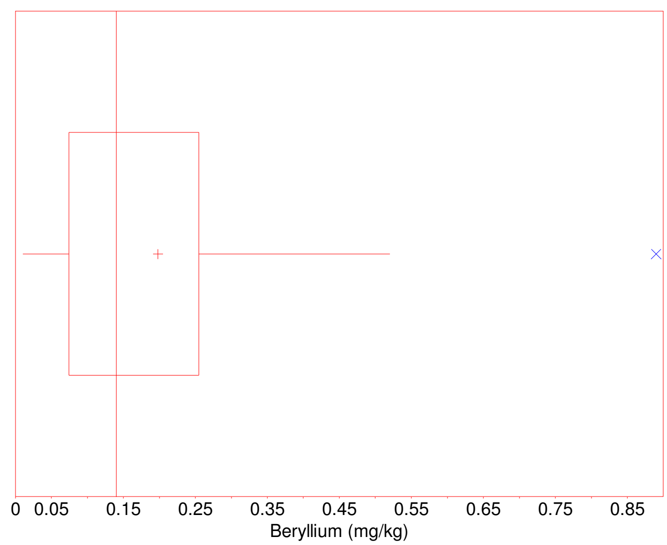
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

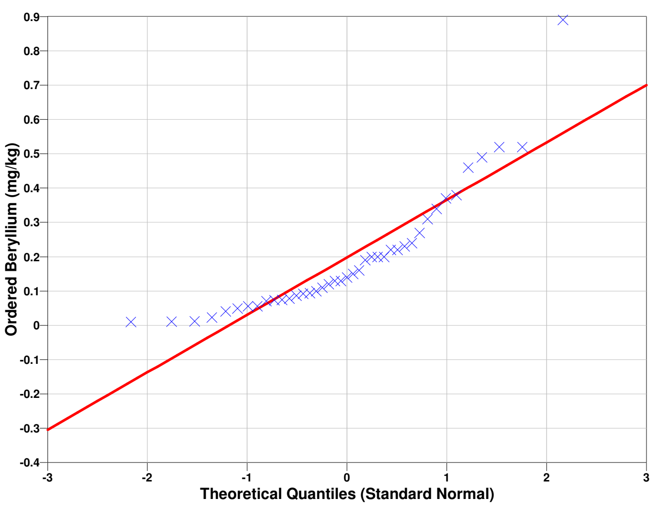
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Beryllium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8343
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.2455
95% Non-Parametric (Chebyshev) UCL	0.3209

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.3209) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-347.83	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Cadmium
The following data points were entered by the user for analysis.

Cadmium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0405	0.0418	0.043	0.045	0.046	0.047	0.0485	0.049	0.0495	0.05
10	0.05	0.0525	0.0525	0.0525	0.055	0.055	0.055	0.055	0.055	0.055
20	0.055	0.055	0.055	0.0575	0.0575	0.0575	0.06	0.06	0.06	0.06
30	0.06	0.065	0.065	0.07	0.12	0.14	0.17	0.19	0.23	0.56
40	1.1									

SUMMARY STATISTICS for Cadmium	
n	41
Min	0.0405
Max	1.1
Range	1.0595
Mean	0.10598
Median	0.055
Variance	0.032888
StdDev	0.18135
Std Error	0.028322
Skewness	4.7306
Interquartile Range	0.0125

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0405	0.04192	0.0452	0.05	0.055	0.0625	0.186	0.527	1.1

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Cadmium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.481	3.05	Yes

The test statistic 5.481 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Cadmium

1	1.1

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.4281
Shapiro-Wilk 5% Critical Value	0.94

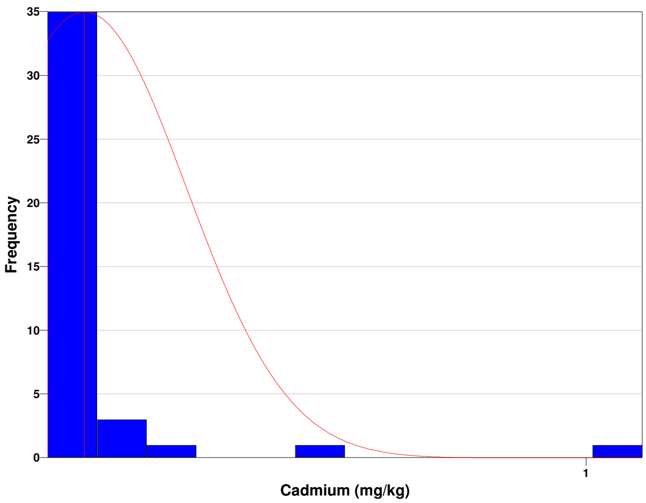
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

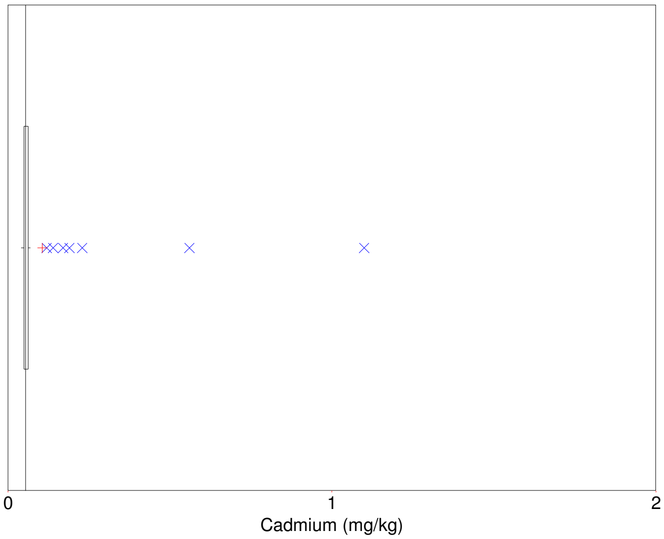
Data Plots for Cadmium
Graphical displays of the data are shown below.

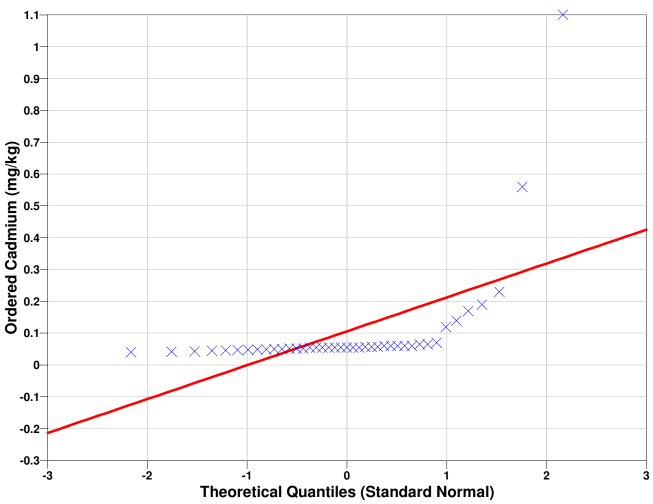
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Cadmium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.3646
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.1537

95% Non-Parametric (Chebyshev) UCL	0.2294

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.2294) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1126.1	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Chromium
The following data points were entered by the user for analysis.

Chromium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.505	0.77	0.9	0.92	1.1	1.4	1.45	1.6	1.71	2
10	2.3	2.8	2.8	2.9	3.6	3.6	3.7	3.8	3.9	4
20	4	4.2	4.5	4.5	4.9	5.05	5.1	5.15	6.4	6.7
30	6.9	7.4	7.8	8.3	8.9	9	9.6	10.4	11.3	13.3
40	14.9									

SUMMARY STATISTICS for Chromium	
n	41
Min	0.505
Max	14.9

Range	14.395
Mean	4.977
Median	4
Variance	12.44
StdDev	3.527
Std Error	0.55082
Skewness	1.0011
Interquartile Range	5

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.505	0.783	0.956	2.15	4	7.15	10.24	13.1	14.9

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Chromium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.813	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9271
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

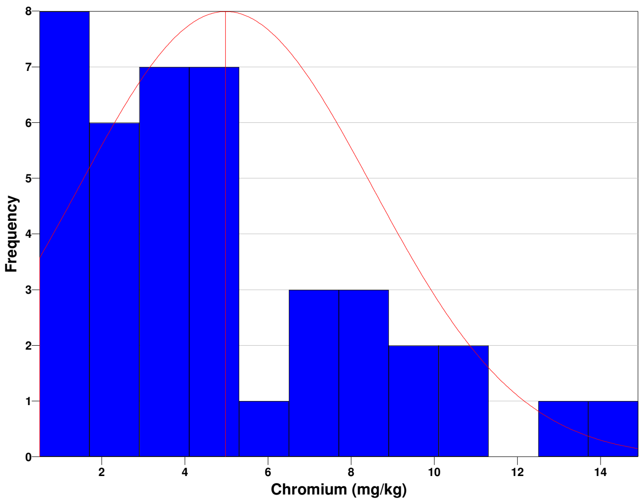
Data Plots for Chromium
Graphical displays of the data are shown below.

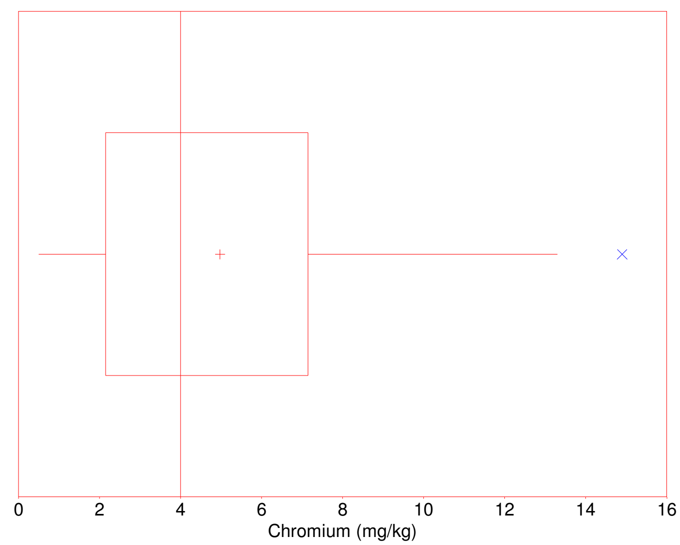
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally

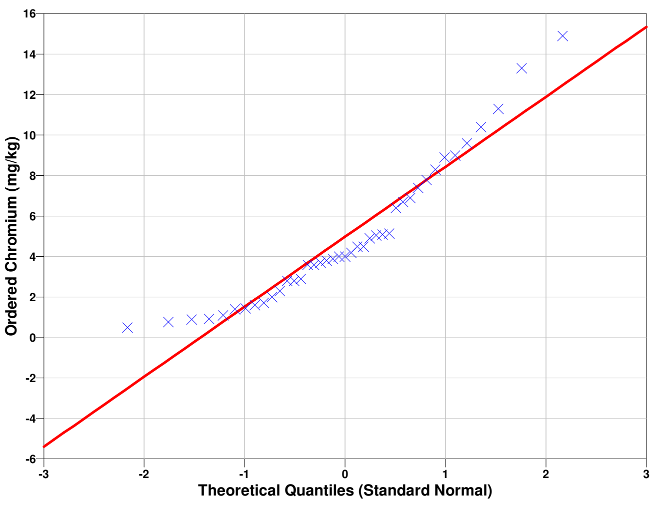
distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Chromium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was

conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9122
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	5.904
95% Non-Parametric (Chebyshev) UCL	7.378

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (7.378) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
8.3093	1.6839	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
0	26	Cannot Reject
Note: There may not be enough data to reject the null hypothesis (and conclude site is clean) with 95% confidence using the MARSSIM sign test.		

Data Analysis for Cobalt
The following data points were entered by the user for analysis.

Cobalt (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.08	0.095	0.1	0.108	0.19	0.2	0.36	0.43	0.44	0.464
10	0.47	0.53	0.61	0.62	0.71	0.74	1	1.1	1.1	1.2
20	1.3	1.3	1.3	1.3	1.3	1.45	1.45	1.5	1.55	1.6
30	1.7	1.7	1.8	2.2	2.3	2.5	2.5	2.8	3	3.3
40	4.6									

SUMMARY STATISTICS for Cobalt								
n	41							
Min	0.08							
Max	4.6							
Range	4.52							
Mean	1.2926							
Median	1.3							
Variance	0.99774							
StdDev	0.99887							
Std Error	0.156							
Skewness	1.1633							
Interquartile Range	1.233							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.08	0.0955	0.1244	0.467	1.3	1.7	2.74	3.27	4.6

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Cobalt			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.311	3.05	Yes

The test statistic 3.311 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Cobalt

1	4.6

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9312
Shapiro-Wilk 5% Critical Value	0.94

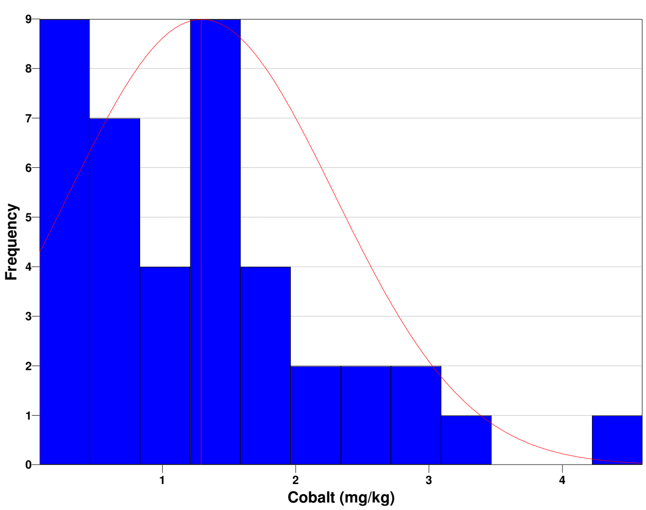
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

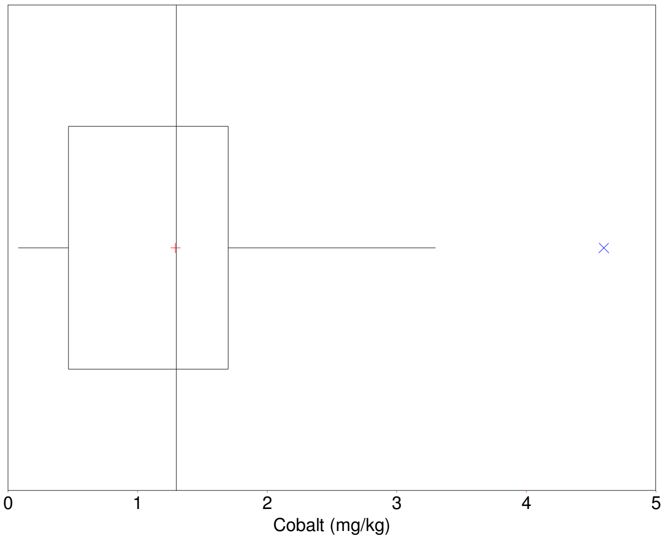
Data Plots for Cobalt
Graphical displays of the data are shown below.

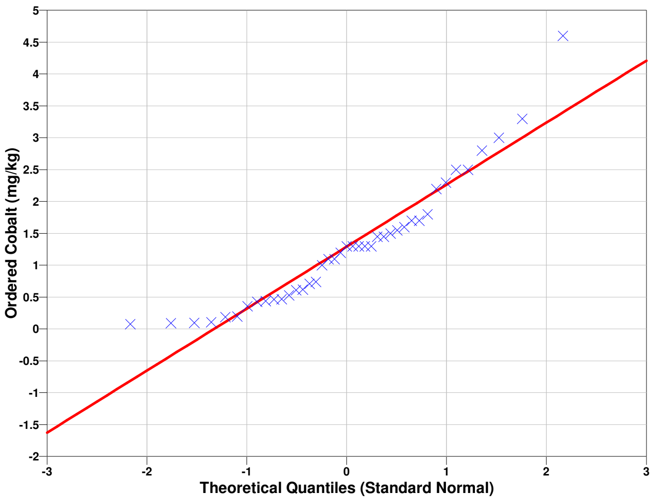
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Cobalt
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9087
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	1.555

95% Non-Parametric (Chebyshev) UCL	1.973

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (1.973) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-75.049	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Copper
The following data points were entered by the user for analysis.

Copper (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.685	0.86	0.93	0.93	0.95	0.99	1	1.01	1.1	1.4
10	1.7	2.2	2.4	2.5	2.5	2.7	2.7	3.1	3.2	3.25
20	3.3	3.3	3.4	3.55	3.6	3.6	3.7	4.2	4.5	4.7
30	4.7	4.8	5.1	5.2	5.7	6.9	8.1	9.6	10.3	10.7
40	23.5									

SUMMARY STATISTICS for Copper	
n	41
Min	0.685
Max	23.5

Range	22.815
Mean	4.1111
Median	3.3
Variance	16.062
StdDev	4.0077
Std Error	0.62589
Skewness	3.1509
Interquartile Range	3.2

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.685	0.867	0.934	1.55	3.3	4.75	9.3	10.66	23.5

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Copper			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.838	3.05	Yes

The test statistic 4.838 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Copper	
1	23.5

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8635
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

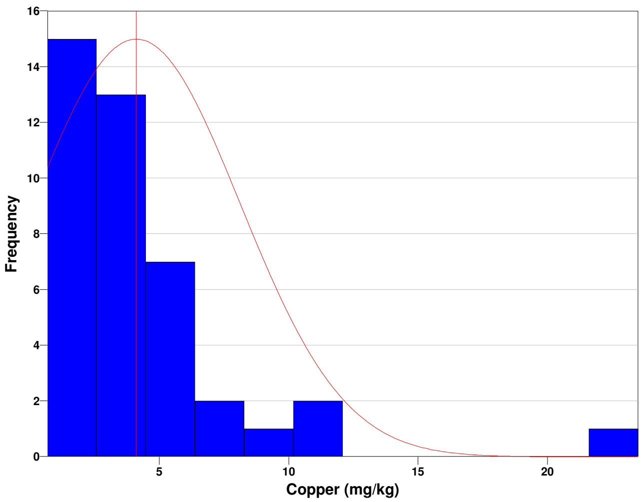
Data Plots for Copper
Graphical displays of the data are shown below.

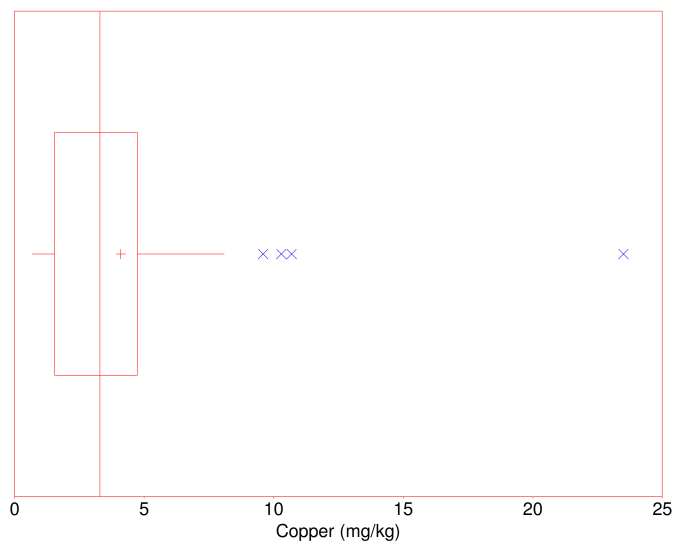
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

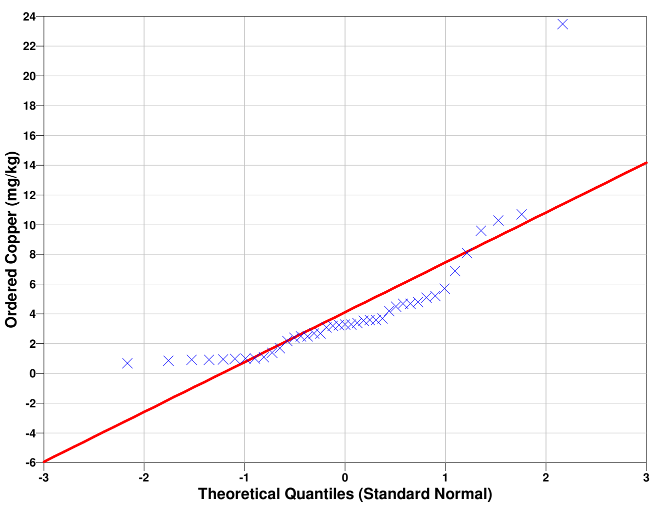
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Copper
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6979
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	5.165
95% Non-Parametric (Chebyshev) UCL	6.839

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (6.839) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-90.892	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Lead
The following data points were entered by the user for analysis.

Lead (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	2.02	2.15	2.45	2.6	3.4	3.6	3.7	3.9	4.6	4.8
10	5.1	5.4	6	6.1	6.7	6.9	6.9	7	7.2	8
20	8.3	8.9	9.2	9.8	9.9	10.4	11.6	12.7	14.8	16.1
30	17.1	17.7	18.8	18.9	19.8	20.9	22.5	23.8	55.8	80.6
40	80.7									

SUMMARY STATISTICS for Lead								
n	41							
Min	2.02							
Max	80.7							
Range	78.68							
Mean	14.313							
Median	8.3							
Variance	320.07							
StdDev	17.891							
Std Error	2.794							
Skewness	2.929							
Interquartile Range	12.45							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
2.02	2.18	2.76	4.95	8.3	17.4	23.54	78.12	80.7

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Lead			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.711	3.05	Yes

The test statistic 3.711 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Lead

1	80.7

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6209
Shapiro-Wilk 5% Critical Value	0.94

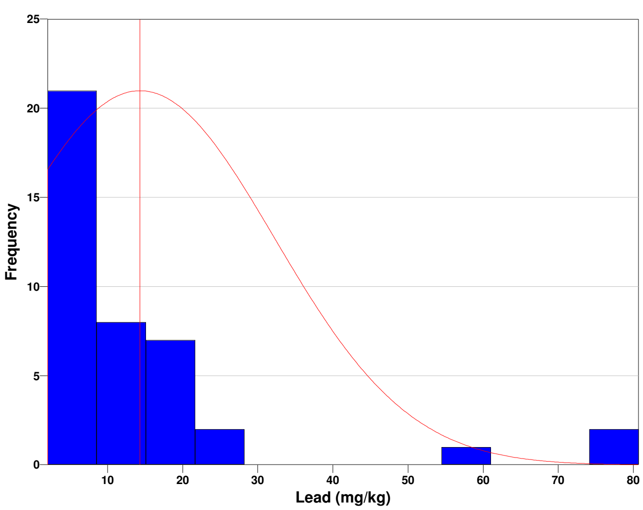
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

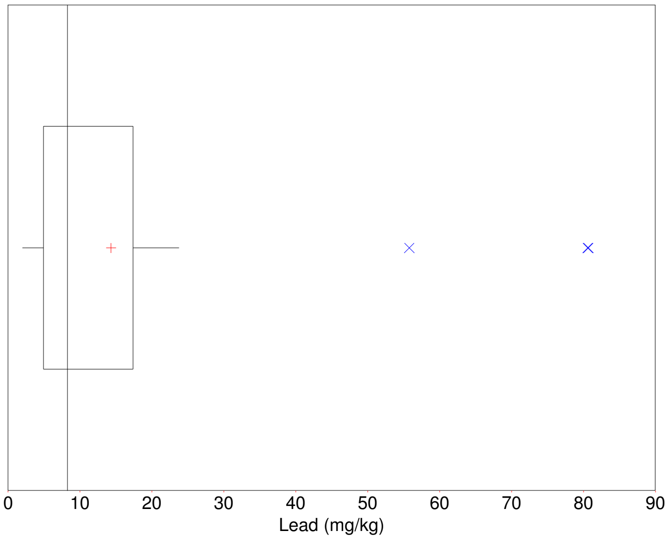
Data Plots for Lead
Graphical displays of the data are shown below.

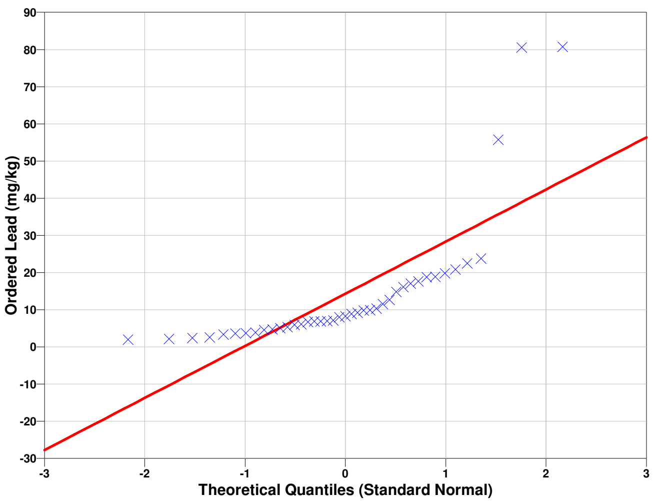
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Lead

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5993
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	19.02

95% Non-Parametric (Chebyshev) UCL	26.49

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (26.49) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-37.826	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Manganese
The following data points were entered by the user for analysis.

Manganese (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	9.3	9.3	10	11.5	15.7	17.7	21.1	21.5	26.4	27.7
10	37.3	39.6	41	42.7	43.6	47.3	49.4	49.4	65.6	66.4
20	69.4	73.6	77	77.5	80.5	92	102	102	104	106
30	110	114	121	141	143	144	146	155	191	207
40	210									

SUMMARY STATISTICS for Manganese	
n	41
Min	9.3
Max	210

Range				200.7				
Mean				78.5				
Median				69.4				
Variance				3110.7				
StdDev				55.773				
Std Error				8.7103				
Skewness				0.73144				
Interquartile Range				79.5				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
9.3	9.37	12.34	32.5	69.4	112	153.2	205.4	210

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Manganese			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.358	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9278
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

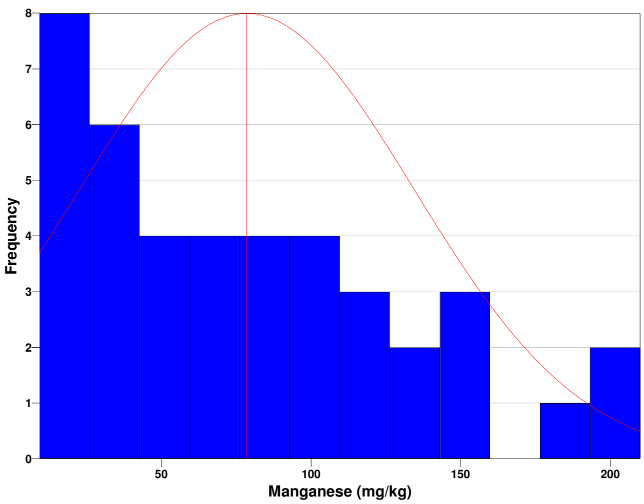
Data Plots for Manganese
Graphical displays of the data are shown below.

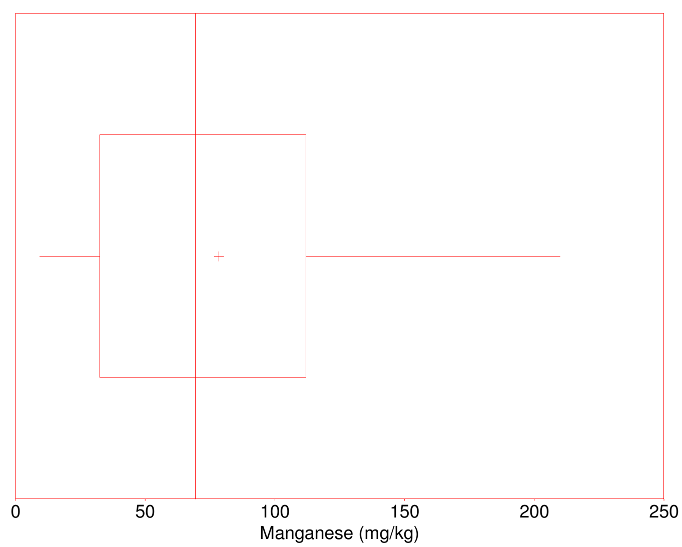
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally

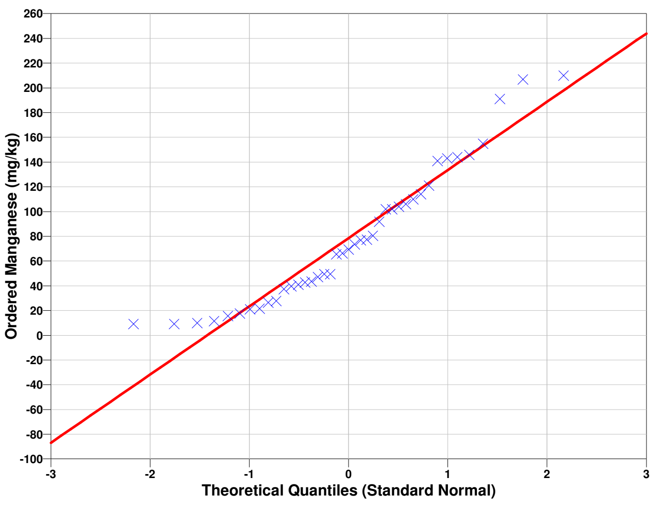
distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Manganese

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was

conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9178
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	93.17
95% Non-Parametric (Chebyshev) UCL	116.5

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (116.5) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-48.391	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Mercury
The following data points were entered by the user for analysis.

Mercury (mg/kg)

Rank	1	2	3	4	5	6	7	8	9	10
0	0.000385	0.0013	0.0014	0.0014	0.0031	0.0037	0.0047	0.00535	0.0054	0.0054
10	0.0065	0.0069	0.007	0.007	0.0072	0.0073	0.0076	0.0079	0.0082	0.0083
20	0.0088	0.0093	0.0095	0.011	0.012	0.013	0.013	0.013	0.014	0.016
30	0.016	0.019	0.0215	0.024	0.024	0.026	0.034	0.034	0.049	0.079
40	0.74									

SUMMARY STATISTICS for Mercury								
n	41							
Min	0.000385							
Max	0.74							
Range	0.73962							
Mean	0.031515							
Median	0.0088							
Variance	0.013073							
StdDev	0.11434							
Std Error	0.017856							
Skewness	6.2472							
Interquartile Range	0.01155							
Percentiles								
1%	5%	10%	25%	50%	75%	90%	95%	99%
0.000385	0.00131	0.00174	0.00595	0.0088	0.0175	0.034	0.076	0.74

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Mercury			
k	Test Statistic R_k	5% Critical Value C_k	Significant?
1	6.197	3.05	Yes

The test statistic 6.197 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Mercury	
1	0.74

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the

suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7171
Shapiro-Wilk 5% Critical Value	0.94

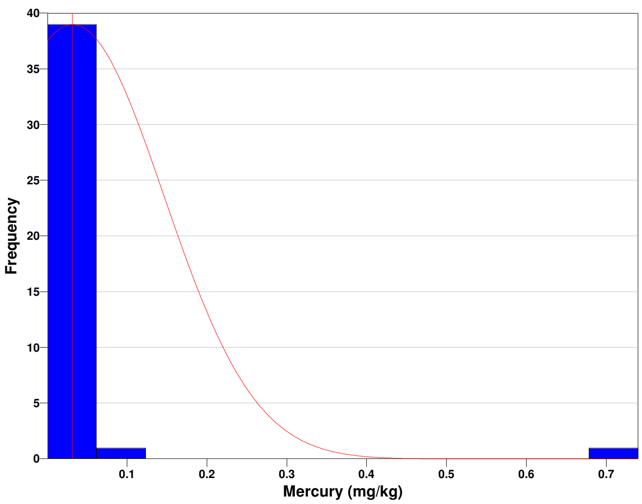
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

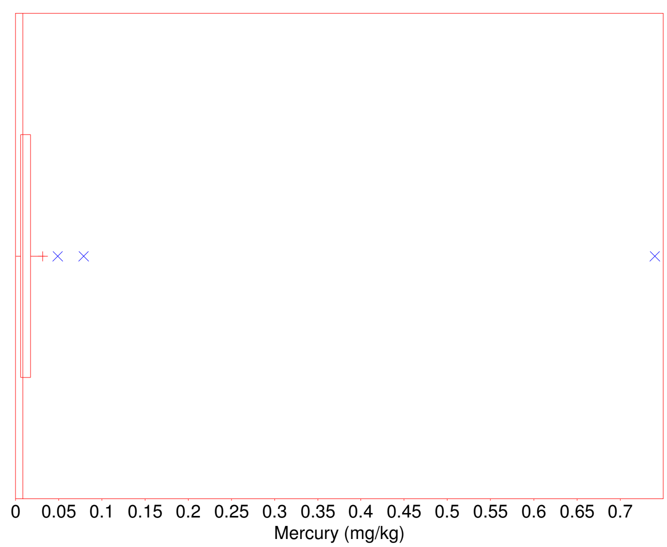
Data Plots for Mercury
Graphical displays of the data are shown below.

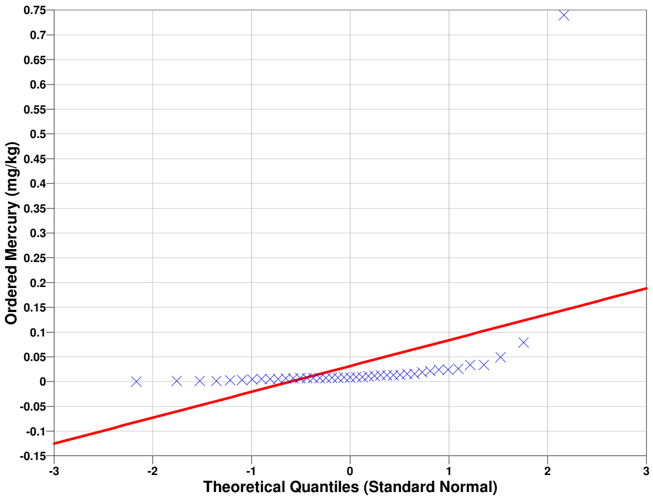
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Mercury
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.2381
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.06158
95% Non-Parametric (Chebyshev) UCL	0.1093

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.1093) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-3.8353	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
40	26	Reject

Data Analysis for Nickel
The following data points were entered by the user for analysis.

Nickel (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0775	0.26	0.27	0.29	0.35	0.48	0.56	0.76	0.81	1
10	1.1	1.2	1.2	1.3	1.3	1.5	1.7	1.8	1.9	2
20	2.1	2.2	2.2	2.4	2.5	2.7	2.95	3.05	3.3	3.4
30	3.4	3.5	4.1	4.2	4.3	4.45	5.1	5.2	5.3	8.6
40	9.3									

SUMMARY STATISTICS for Nickel								
n	41							
Min	0.0775							
Max	9.3							
Range	9.2225							
Mean	2.5392							
Median	2.1							
Variance	4.3557							
StdDev	2.087							
Std Error	0.32594							
Skewness	1.4641							
Interquartile Range	2.4							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0775	0.261	0.302	1.05	2.1	3.45	5.18	8.27	9.3

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Nickel			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.239	3.05	Yes

The test statistic 3.239 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Nickel	
1	9.3

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9125
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

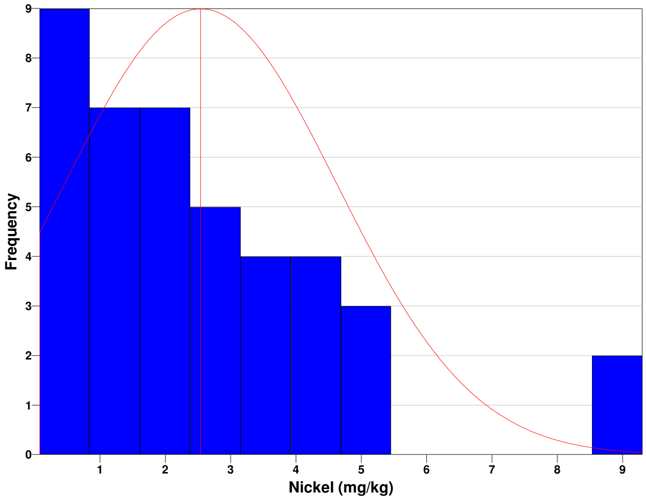
Data Plots for Nickel
Graphical displays of the data are shown below.

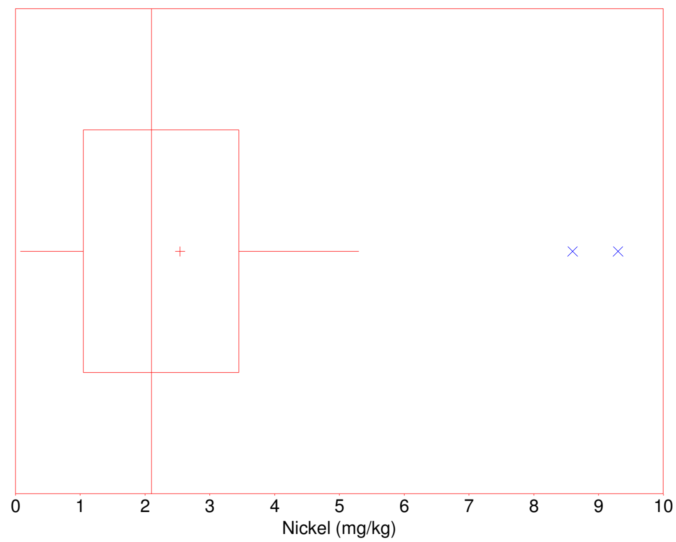
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

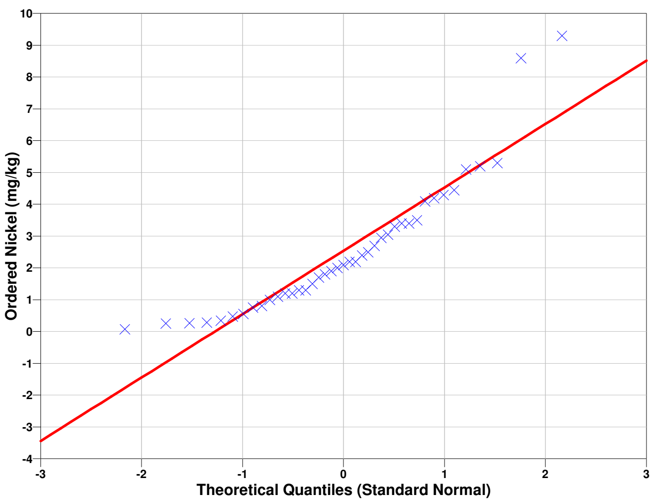
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the

Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Nickel
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8731
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	3.088
95% Non-Parametric (Chebyshev) UCL	3.96

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (3.96) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-84.251	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Toluene
The following data points were entered by the user for analysis.

Toluene (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00065	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.00075	0.00075
10	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.000775	0.0008
20	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
30	0.0008	0.0008	0.0008	0.00085	0.00085	0.0009	0.0011	0.0014	0.0015	0.0039
40	0.0044									

SUMMARY STATISTICS for Toluene	
n	41

Min				0.00065				
Max				0.0044				
Range				0.00375				
Mean				0.00097378				
Median				0.0008				
Variance				5.6012e-007				
StdDev				0.00074841				
Std Error				0.00011688				
Skewness				4.0831				
Interquartile Range				5e-005				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00065	0.0007	0.0007	0.00075	0.0008	0.0008	0.00134	0.00366	0.0044

Outlier Test

Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Toluene			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.578	3.05	Yes

The test statistic 4.578 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Toluene	
1	0.0044

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.3454
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

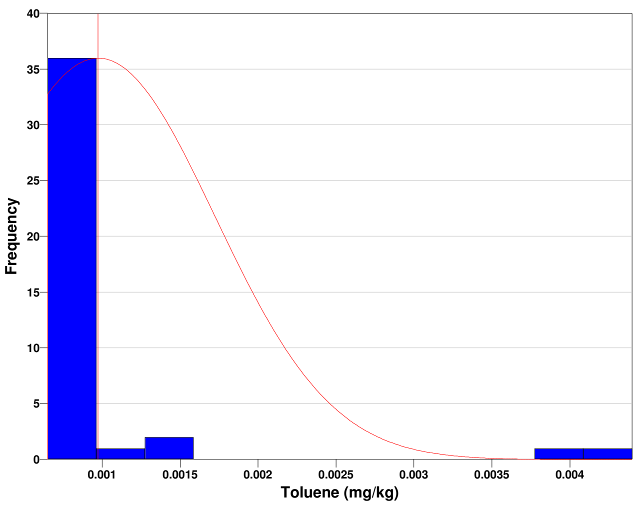
Data Plots for Toluene

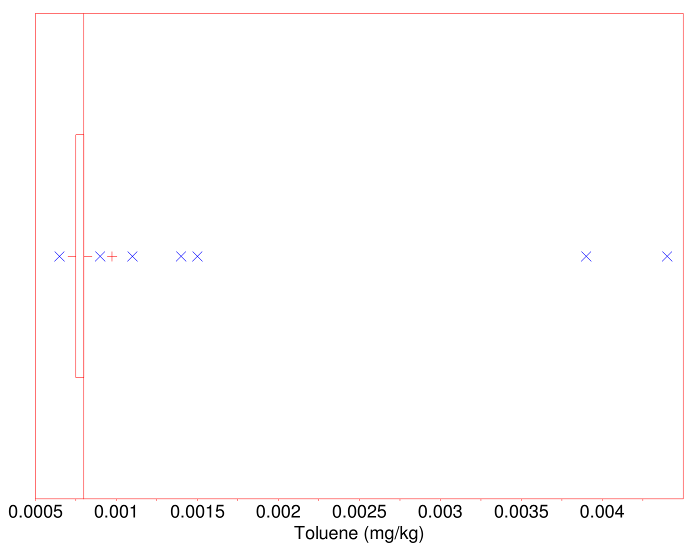
Graphical displays of the data are shown below.

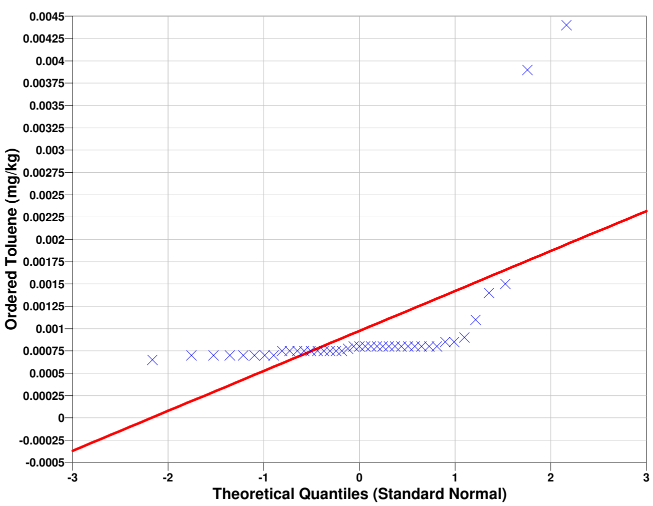
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Toluene

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.3684
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.001171
95% Non-Parametric (Chebyshev) UCL	0.001483

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.001483) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test

A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where

x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.7111e+006	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**

41	26	Reject

Data Analysis for Vanadium
The following data points were entered by the user for analysis.

Vanadium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.985	1.1	1.1	1.3	1.6	1.7	2.1	2.3	2.4	2.4
10	2.93	3.5	4.1	4.1	4.5	4.7	4.8	4.9	5.1	5.1
20	5.25	5.8	6.1	6.6	6.85	7	7.7	7.8	9.1	9.6
30	10.5	10.6	12.8	13.2	15.8	16	16.2	16.6	17.3	22.3
40	29.3									

SUMMARY STATISTICS for Vanadium	
n	41
Min	0.985
Max	29.3
Range	28.315
Mean	7.637
Median	5.25
Variance	40.719
StdDev	6.3812
Std Error	0.99657
Skewness	1.4668
Interquartile Range	7.885

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.985	1.1	1.36	2.665	5.25	10.55	16.52	21.8	29.3

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Vanadium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.395	3.05	Yes

The test statistic 3.395 exceeded the corresponding critical value, therefore that test is significant and we conclude that the

most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Vanadium	
1	29.3

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8818
Shapiro-Wilk 5% Critical Value	0.94

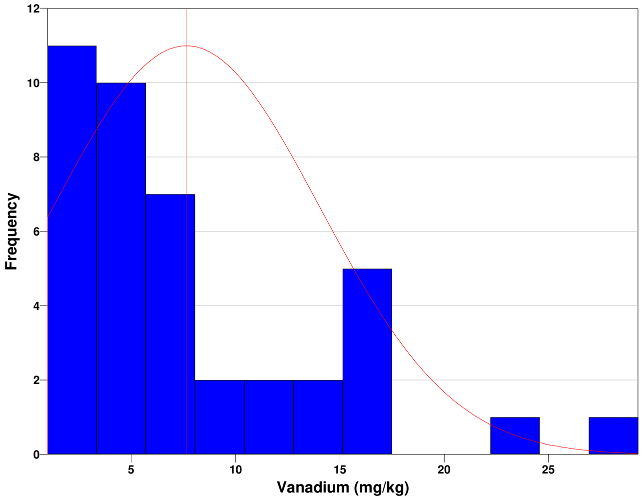
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

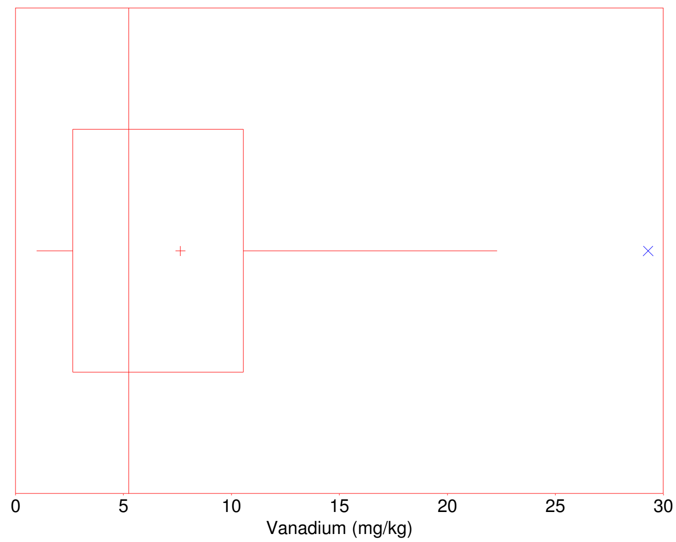
Data Plots for Vanadium
Graphical displays of the data are shown below.

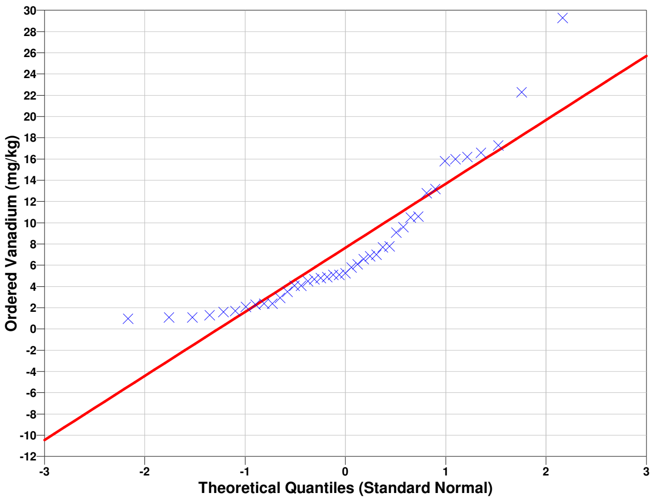
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Vanadium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8548
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	9.315

95% Non-Parametric (Chebyshev) UCL	11.98

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (11.98) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
5.6564	1.6839	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
6	26	Cannot Reject
Note: There may not be enough data to reject the null hypothesis (and conclude site is clean) with 95% confidence using the MARSSIM sign test.		

Data Analysis for Zinc
The following data points were entered by the user for analysis.

Zinc (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	3.1	6.1	8.7	10.4	10.6	11.1	12.2	16.6	17.2	19.7
10	20.1	22.2	22.8	23.6	25.2	25.9	26.1	26.2	29.4	29.8
20	30.2	31.1	31.8	35	39.5	40.2	40.7	40.7	44.1	48
30	48.5	59	59	79	80.3	85.3	92.6	129	143	156
40	232									

SUMMARY STATISTICS for Zinc

n	41
Min	3.1
Max	232
Range	228.9
Mean	46.634
Median	30.2
Variance	2169.2
StdDev	46.575
Std Error	7.2737
Skewness	2.2859
Interquartile Range	33.85

Percentiles

1%	5%	10%	25%	50%	75%	90%	95%	99%
3.1	6.36	10.44	19.9	30.2	53.75	121.7	154.7	232

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Zinc

k	Test Statistic R_k	5% Critical Value C_k	Significant?
1	3.98	3.05	Yes

The test statistic 3.98 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Zinc	
1	232

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.799
Shapiro-Wilk 5% Critical Value	0.94

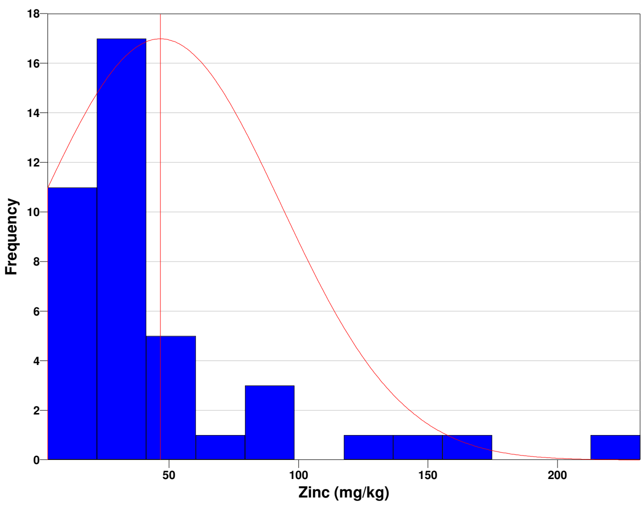
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

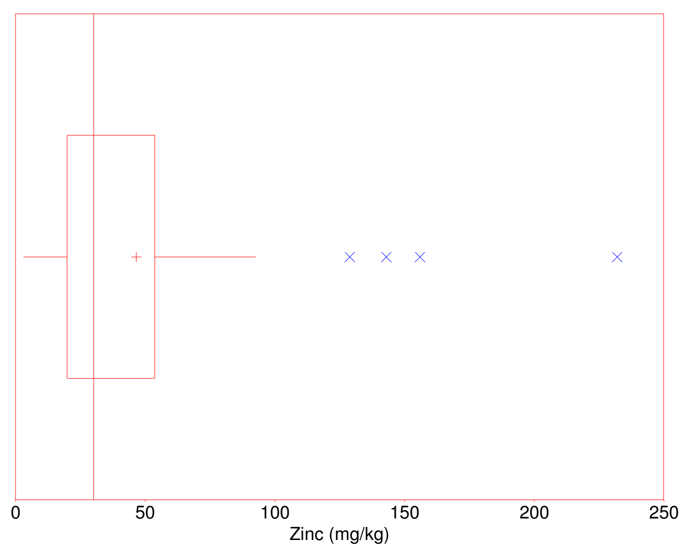
Data Plots for Zinc
Graphical displays of the data are shown below.

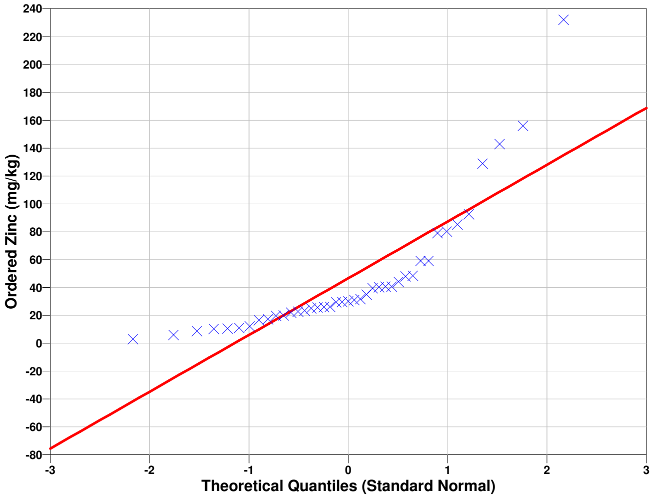
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Zinc
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7459
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	58.88
95% Non-Parametric (Chebyshev) UCL	78.34

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (78.34) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-10.086	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
37	26	Reject

Appendix C

VSP Reports of Calculated Minimum Sample Quantity
Report 5
Area of Concern – 1
Minimum Sample Quantity Calculation for Surface Soil using Human Health Benchmarks and Delta Method 2

Random sampling locations for comparing a mean with a fixed threshold (parametric)

Summary
This report summarizes the sampling design, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design for Arsenic, the driving analyte (the analyte which required the largest number of samples). A figure that shows sampling locations in the field and a table that lists sampling location coordinates are also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean to a fixed threshold
Type of Sampling Design	Parametric
Sample Placement (Location) in the Field	Simple random sampling
Working (Null) Hypothesis	The mean value at the site exceeds the threshold
Formula for calculating number of sampling locations	Student's t-test
Calculated total number of samples	50
Number of samples on map [a]	50
Number of selected sample areas [b]	1
Specified sampling area [c]	188054.34 m^2
Total cost of sampling [d]	$26,000.00

[a] This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[d] Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.

Area: Area 3					
X Coord	**Y Coord**	**Label**	**Value**	**Type**	**Historical**
679133.4290	3083306.3130	J-01S		Manual	T
679104.2450	3083223.2620	J-02S		Manual	T
679155.0740	3083294.6960	J-03S		Manual	T
679171.2970	3083289.7960	J-04S		Manual	T
679225.8560	3083359.9740	J-05S		Manual	T

679164.8060	3083214.7100	J-06S		Manual	T
679242.7260	3083326.5280	J-07S		Manual	T
679181.2750	3083178.2880	J-08S		Manual	T
679213.7730	3083224.9730	J-09S		Manual	T
679280.5440	3083305.6810	J-10S		Manual	T
679268.7700	3083200.3260	J-11S		Manual	T
679301.1600	3083254.0340	J-12S		Manual	T
679149.4920	3082933.0980	J-13S		Manual	T
679279.6830	3083075.4290	J-14S		Manual	T
679261.0980	3083016.3510	J-15S		Manual	T
679222.6340	3082840.1720	J-16S		Manual	T
679293.5600	3082950.4980	J-17S		Manual	T
679360.5700	3083026.4980	J-18S		Manual	T
679343.5810	3082969.5980	J-19S		Manual	T
679382.8640	3083009.1130	J-20S		Manual	T
679335.0020	3082941.1720	J-21S		Manual	T
679252.7130	3082781.0290	J-22S		Manual	T
679297.0010	3082840.6970	J-23S		Manual	T
679394.8070	3082971.8300	J-24S		Manual	T
679146.6460	3082549.7640	J-25S		Manual	T
679224.5850	3082683.1400	J-26S		Manual	T
679169.0760	3082537.3510	J-27S		Manual	T
679272.0040	3082652.6750	J-28S		Manual	T
679329.4380	3082711.0960	J-29S		Manual	T
679374.4420	3082791.3300	J-30S		Manual	T
679410.1490	3082845.8460	J-31S		Manual	T
679453.4760	3082914.1150	J-32S		Manual	T
679495.8840	3082940.9730	J-33S		Manual	T
679304.6530	3082548.6880	J-34S		Manual	T
679342.7410	3082605.3190	J-35S		Manual	T
679382.8900	3082667.5270	J-36S		Manual	T
679433.9450	3082731.6820	J-37S		Manual	T
679470.3570	3082776.7350	J-38S		Manual	T
679497.3310	3082840.3960	J-39S		Manual	T
679524.3310	3082886.8990	J-40S		Manual	T
679560.6070	3082897.2580	J-41S		Manual	T
679185.1410	3082766.9873		0	Adaptive-Fill	
679232.8051	3082939.5189		0	Adaptive-Fill	
679247.1231	3082557.5055		0	Adaptive-Fill	
679164.4208	3082869.5308		0	Adaptive-Fill	
679343.4646	3083305.1385		0	Adaptive-Fill	

679171.5874	3083356.0676		0	Adaptive-Fill	
679295.2725	3082747.2390		0	Adaptive-Fill	
679426.6715	3082681.0369		0	Adaptive-Fill	
679348.7114	3082559.4448		0	Adaptive-Fill	

Primary Sampling Objective
The primary purpose of sampling at this site is to compare a mean value of a site with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the mean value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the mean value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative hypothesis, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach
A parametric random sampling approach was used to determine the number of samples and to specify sampling locations. A parametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that parametric assumptions are reasonable. These assumptions will be examined in post-sampling data analysis.

Both parametric and non-parametric approaches rely on assumptions about the population. However, non-parametric approaches typically require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than the number of samples required by non-parametric approaches.

Locating the sample points randomly provides data that are separated by many distances, whereas systematic samples are all equidistant apart. Therefore, random sampling provides more information about the spatial structure of the potential contamination than systematic sampling does. As with systematic sampling, random sampling also provides information regarding the mean value, but there is the possibility that areas of the site will not be represented with the same frequency as if uniform grid sampling were performed.

Number of Total Samples: Calculation Equation and Inputs
The equation used to calculate the number of samples is based on a Student's t-test. For this site, the null hypothesis is rejected in favor of the alternative hypothesis if the sample mean is sufficiently smaller than the threshold. The number of samples to collect is calculated so that 1) there will be a high probability ($1-\beta$) of rejecting the null hypothesis if the alternative hypothesis is true and 2) a low probability (α) of rejecting the null hypothesis if the null hypothesis is true.

The formula used to calculate the number of samples is:

$$n = \frac{S^2}{\Delta^2}\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2 + 0.5Z_{1-\alpha}^2$$

where
n is the number of samples,
S is the estimated standard deviation of the measured values including analytical error,
Δ is the width of the gray region,
α is the acceptable probability of incorrectly concluding the site mean is less than the threshold,
β is the acceptable probability of incorrectly concluding the site mean exceeds the threshold,
$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is $1-\alpha$,
$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is $1-\beta$.

The values of these inputs that result in the calculated number of sampling locations are:

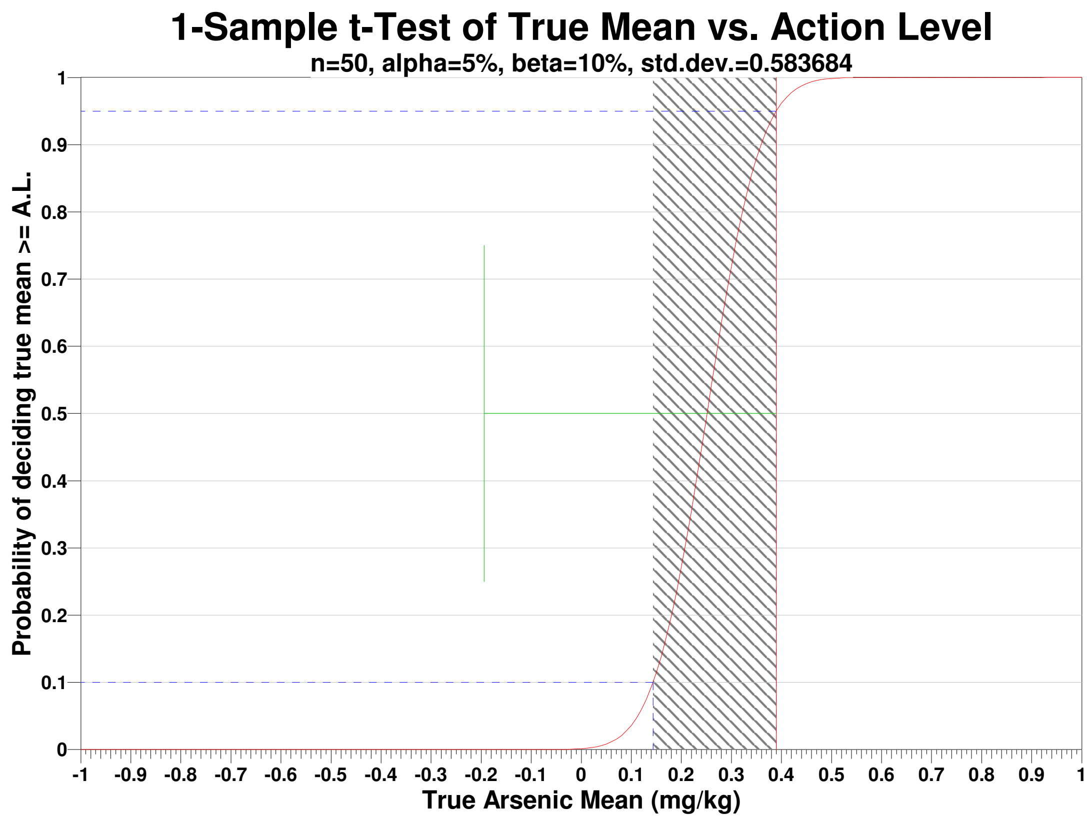
Analyte	n	Parameter					
		S	Δ	α	β	$Z_{1-\alpha}$ [a]	$Z_{1-\beta}$ [b]
New Location	2	0.1 mg/kg	10 mg/kg	0.05	0.1	1.64485	1.28155
1_2_4-Trimethylbenzene	2	0.0247235 mg/kg	52.1389 mg/kg	0.05	0.1	1.64485	1.28155
Acetone	2	0.0411995 mg/kg	5417.38 mg/kg	0.05	0.1	1.64485	1.28155

Aluminum	13	3361.66 mg/kg	2967.33 mg/kg	0.05	0.1	1.64485	1.28155
Arsenic	50	0.583684 mg/kg	0.24623 mg/kg	0.05	0.1	1.64485	1.28155
Barium	2	25.3192 mg/kg	7809.96 mg/kg	0.05	0.1	1.64485	1.28155
Beryllium	2	0.10236 mg/kg	37.4504 mg/kg	0.05	0.1	1.64485	1.28155
Carbon Disulfide	2	0.000685674 mg/kg	721.253 mg/kg	0.05	0.1	1.64485	1.28155
Chromium	2	2.69493 mg/kg	207.587 mg/kg	0.05	0.1	1.64485	1.28155
Chromium_ Hexavalent	2	0.24852 mg/kg	29.4197 mg/kg	0.05	0.1	1.64485	1.28155
Cobalt	2	0.499145 mg/kg	902.336 mg/kg	0.05	0.1	1.64485	1.28155
Copper	2	1.26381 mg/kg	546.111 mg/kg	0.05	0.1	1.64485	1.28155
Diethyl phthalate	2	0.0507891 mg/kg	1424.32 mg/kg	0.05	0.1	1.64485	1.28155
Lead	2	3.95601 mg/kg	396.248 mg/kg	0.05	0.1	1.64485	1.28155
Manganese	2	53.722 mg/kg	3196.46 mg/kg	0.05	0.1	1.64485	1.28155
Mercury	2	0.0917868 mg/kg	2.06245 mg/kg	0.05	0.1	1.64485	1.28155
Methylene chloride	2	0.0159472 mg/kg	1.25376 mg/kg	0.05	0.1	1.64485	1.28155
Nickel	2	1.42019 mg/kg	830.77 mg/kg	0.05	0.1	1.64485	1.28155
Vanadium	2	3.39634 mg/kg	287.058 mg/kg	0.05	0.1	1.64485	1.28155
Xylene (total)	2	0.00342404 mg/kg	214.477 mg/kg	0.05	0.1	1.64485	1.28155
Zinc	2	5.98673 mg/kg	9914.06 mg/kg	0.05	0.1	1.64485	1.28155

[a] This value is automatically calculated by VSP based upon the user defined value of α.
[b] This value is automatically calculated by VSP based upon the user defined value of β.

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000) for Arsenic, the driving analyte. It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true mean values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at 1-α on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at 1-α. If any of the inputs change, the number of samples that result in the correct curve changes.



Statistical Assumptions

The assumptions associated with the formulas for computing the number of samples are:

1. the sample mean is normally distributed (this happens if the data are roughly symmetric or the sample size is more than 30; for extremely skewed data sets, additional samples may be required for the sample mean to be normally distributed),
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected randomly.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the sample locations were selected using a random process.

Sensitivity Analysis

The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that μ > action level and alpha (%), probability of mistakenly concluding that μ < action level. The following table shows the results of this analysis.

Number of Samples							
AL=0.389624		α=5		α=10		α=15	
		s=1.16737	s=0.583684	s=1.16737	s=0.583684	s=1.16737	s=0.583684
LBGR=90	β=5	9717	2431	7689	1923	6455	1614
	β=10	7689	1924	5899	1476	4824	1207
	β=15	6456	1615	4825	1207	3858	965
LBGR=80	β=5	2431	609	1923	482	1614	404
	β=10	1924	482	1476	370	1207	302
	β=15	1615	405	1207	303	965	242
LBGR=70	β=5	1081	272	856	215	718	180

	β=10	856	215	657	165	537	135
	β=15	719	181	537	135	430	108

s = Standard Deviation
LBGR = Lower Bound of Gray Region (% of Action Level)
β = Beta (%), Probability of mistakenly concluding that μ > action level
α = Alpha (%), Probability of mistakenly concluding that μ < action level
AL = Action Level (Threshold)

Cost of Sampling
The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that are based on the number of samples collected and measured. Based on the numbers of samples determined above, the estimated total cost of sampling and analysis at this site is $26,000.00, which averages out to a per sample cost of $520.00. The following table summarizes the inputs and resulting cost estimates.

COST INFORMATION			
Cost Details	**Per Analysis**	**Per Sample**	**50 Samples**
Field collection costs		$100.00	$5,000.00
Analytical costs	$400.00	$400.00	$20,000.00
Sum of Field & Analytical costs		**$500.00**	**$25,000.00**
Fixed planning and validation costs			$1,000.00
Total cost			**$26,000.00**

Data Analysis for New Location
The following data points were entered by the user for analysis.

New Location (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0		

SUMMARY STATISTICS for New Location	
n	38
Min	0
Max	0
Range	0
Mean	0
Median	0
Variance	0
StdDev	0
Std Error	0
Skewness	-1.#IND
Interquartile Range	0

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0	0	0	0	0	0	0	0	0

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for New Location			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	-1.#IO	3.01	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0
Shapiro-Wilk 5% Critical Value	0.936

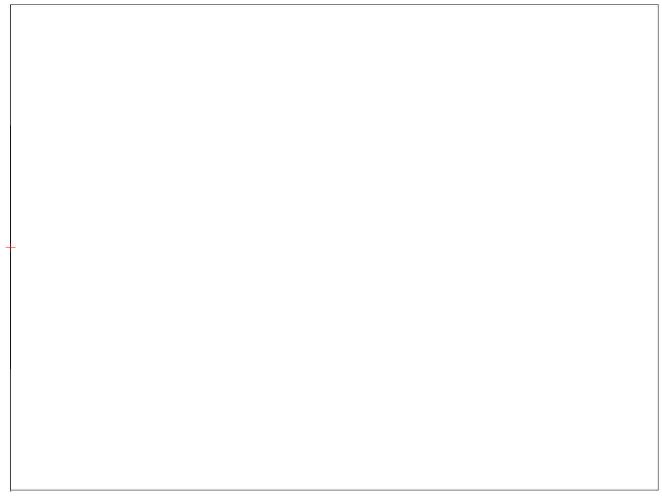
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

Data Plots for New Location
Graphical displays of the data are shown below.

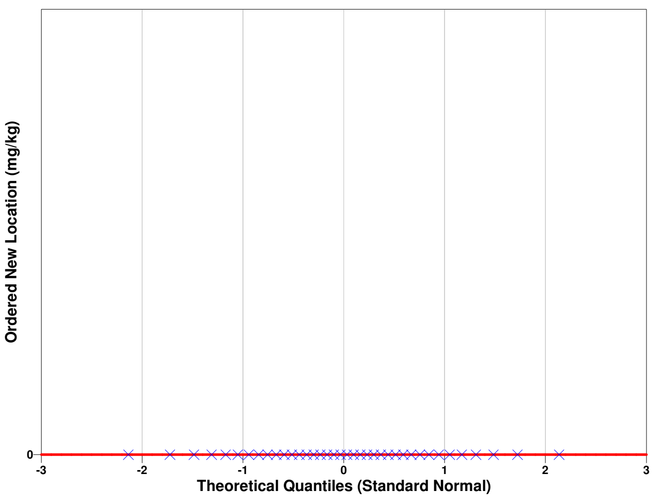
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.



New Location (mg/kg)



For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for New Location

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0
Shapiro-Wilk 5% Critical Value	0.938

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that

assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0
95% Non-Parametric (Chebyshev) UCL	0

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=38 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=37 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.#IND	1.6871	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
-1	-1	Reject

Data Analysis for 1_2_4-Trimethylbenzene
The following data points were entered by the user for analysis.

1_2_4-Trimethylbenzene (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00055	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006
10	0.0006	0.00065	0.00065	0.00065	0.00065	0.00065	0.00065	0.00065	0.00065	0.00065
20	0.00065	0.00065	0.00065	0.00065	0.00065	0.00065	0.00065	0.00065	0.0007	0.0007
30	0.0007	0.0007	0.0007	0.0007	0.0007	0.00075	0.0017	0.0022	0.0025	0.0796
40	0.14									

SUMMARY STATISTICS for 1_2_4-Trimethylbenzene

n	41
Min	0.00055
Max	0.14
Range	0.13945
Mean	0.0060793
Median	0.00065
Variance	0.00061125
StdDev	0.024723
Std Error	0.0038612
Skewness	4.8579
Interquartile Range	0.0001

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00055	0.0006	0.0006	0.0006	0.00065	0.0007	0.0021	0.07189	0.14

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for 1_2_4-Trimethylbenzene			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.417	3.05	Yes

The test statistic 5.417 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for 1_2_4-Trimethylbenzene	
1	0.14

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.1749
Shapiro-Wilk 5% Critical Value	0.94

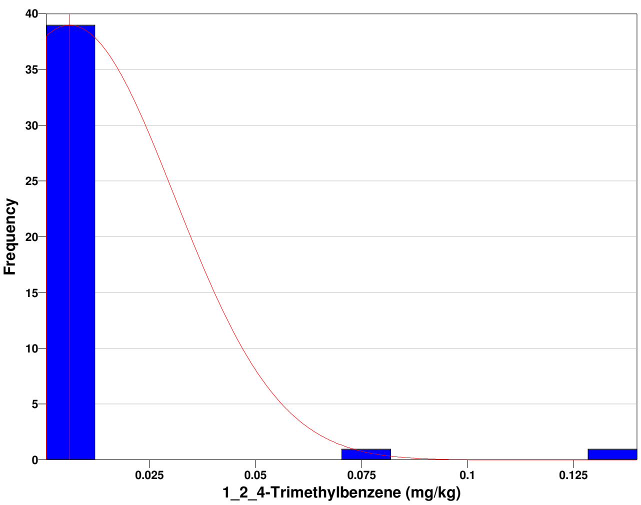
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

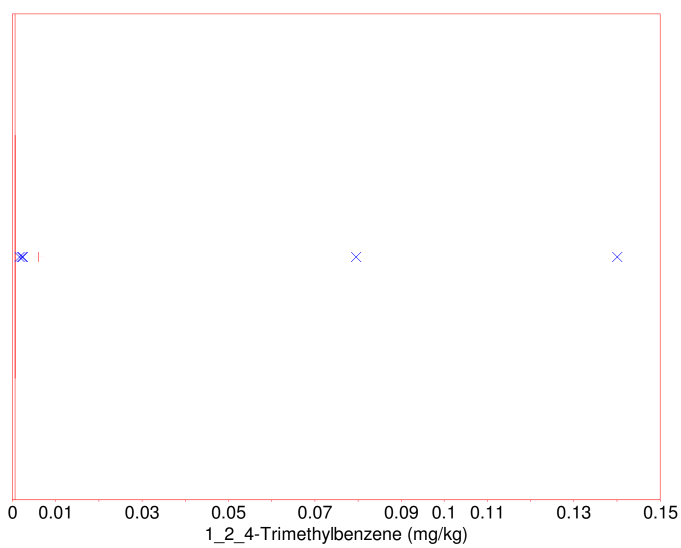
Data Plots for 1_2_4-Trimethylbenzene
Graphical displays of the data are shown below.

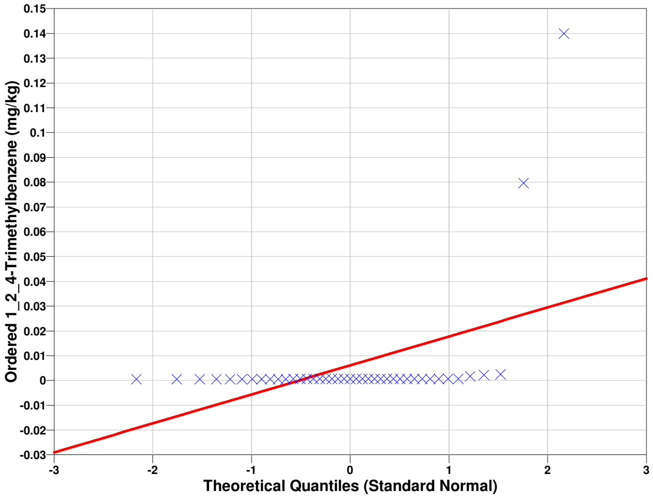
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for 1_2_4-Trimethylbenzene
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.2457
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.01258
95% Non-Parametric (Chebyshev) UCL	0.02291

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.02291) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-13503	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Acetone
The following data points were entered by the user for analysis.

Acetone (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0041	0.0041	0.0041	0.00415	0.0042	0.00425	0.00435	0.0044	0.0046	0.0046
10	0.0082	0.0092	0.01	0.0109	0.0112	0.0127	0.0127	0.0127	0.0155	0.0158
20	0.0163	0.0179	0.0199	0.0219	0.0228	0.0234	0.0259	0.0265	0.0268	0.027
30	0.0307	0.0324	0.0326	0.0337	0.034	0.035	0.047	0.0675	0.0697	0.109
40	0.249									

SUMMARY STATISTICS for Acetone								
n	41							
Min	0.0041							
Max	0.249							
Range	0.2449							
Mean	0.027579							
Median	0.0163							
Variance	0.0016974							
StdDev	0.041199							
Std Error	0.0064342							
Skewness	4.2737							
Interquartile Range	0.02515							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0041	0.0041	0.00416	0.0064	0.0163	0.03155	0.0634	0.1051	0.249

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Acetone			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.374	3.05	Yes

The test statistic 5.374 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Acetone	
1	0.249

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7667
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

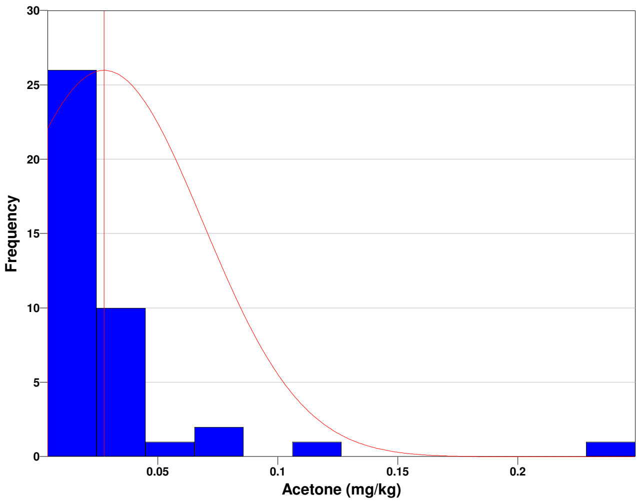
Data Plots for Acetone
Graphical displays of the data are shown below.

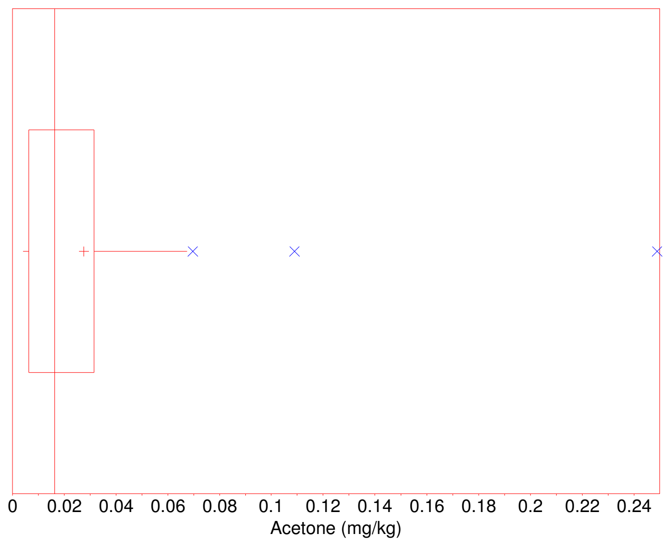
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

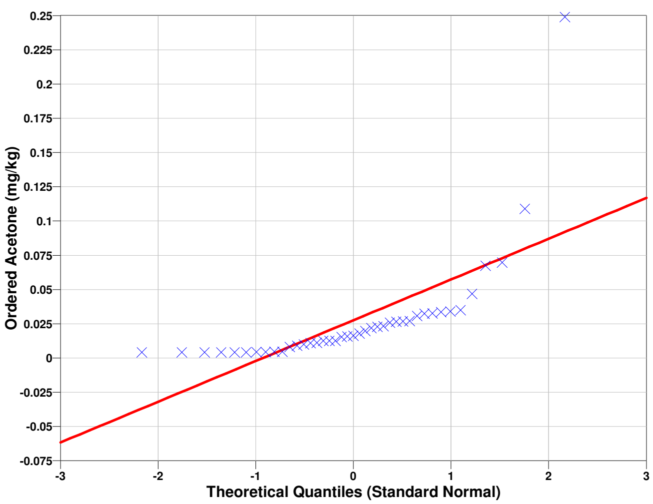
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the

Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Acetone
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5344
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.03841
95% Non-Parametric (Chebyshev) UCL	0.05563

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.05563) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-8.4196e+005	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Aluminum
The following data points were entered by the user for analysis.

Aluminum (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	648	747	748	790	858	915	917	959	1090	1110
10	1130	1160	1200	1240	1390	1500	1760	1770	1830	1960
20	2140	2250	2460	2480	2800	3310	3510	3630	3640	4180
30	4660	5140	5880	6880	7640	7690	8450	9150	1.09e+004	1.14e+004
40	1.38e+004									

SUMMARY STATISTICS for Aluminum	
n	41

Min	648							
Max	13800							
Range	13152							
Mean	3554							
Median	2140							
Variance	1.13e+007							
StdDev	3361.6							
Std Error	524.99							
Skewness	1.4859							
Interquartile Range	3780							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
648	747.1	803.6	1120	2140	4900	9010	1.135e+004	1.38e+004

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Aluminum			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.048	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

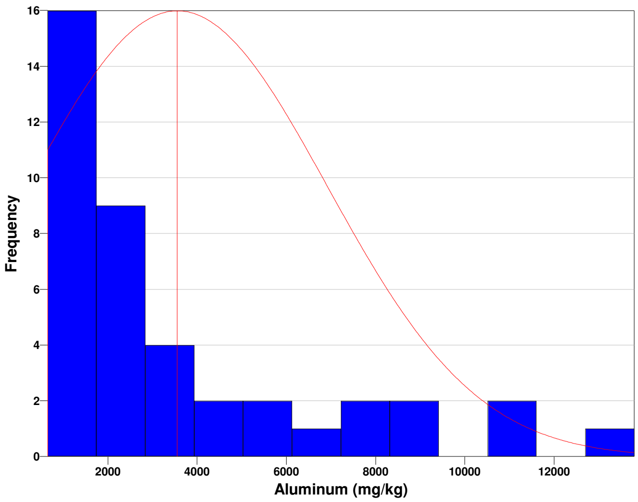
Data Plots for Aluminum
Graphical displays of the data are shown below.

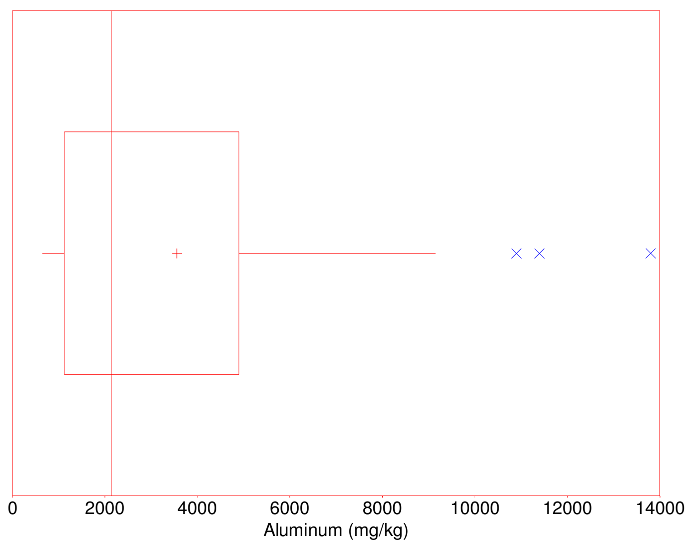
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each

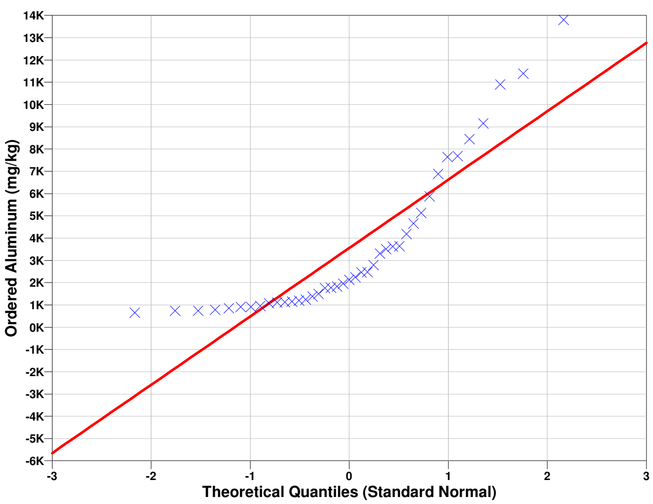
bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Aluminum
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7943
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	4438
95% Non-Parametric (Chebyshev) UCL	5842

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (5842) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-5.6519	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
33	26	Reject

Data Analysis for Arsenic
The following data points were entered by the user for analysis.

Arsenic (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.08	0.09	0.1	0.1	0.105	0.105	0.11	0.115	0.115	0.12
10	0.14	0.23	0.23	0.26	0.29	0.3	0.33	0.34	0.38	0.41
20	0.44	0.47	0.54	0.54	0.58	0.62	0.7	0.74	0.78	0.8
30	0.81	1	1	1.1	1.2	1.4	1.7	1.7	1.7	2.1
40	2.2									

SUMMARY STATISTICS for Arsenic								
n	41							
Min	0.08							
Max	2.2							
Range	2.12							
Mean	0.63585							
Median	0.44							
Variance	0.34069							
StdDev	0.58368							
Std Error	0.091156							
Skewness	1.2458							
Interquartile Range	0.775							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.08	0.091	0.101	0.13	0.44	0.905	1.7	2.06	2.2

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Arsenic			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.68	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the

suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8461
Shapiro-Wilk 5% Critical Value	0.94

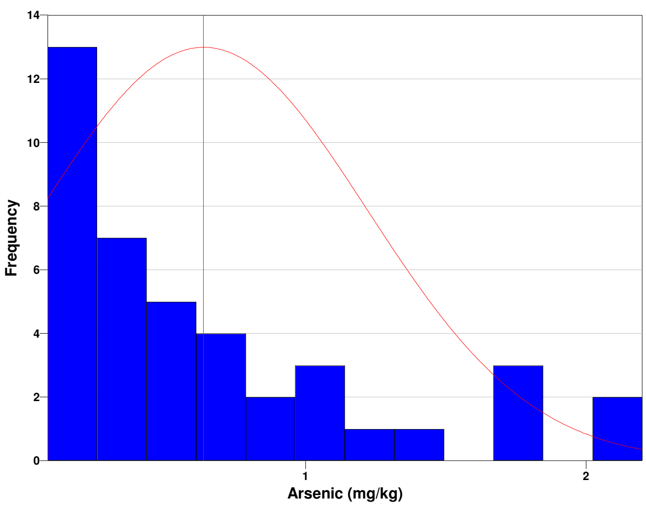
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

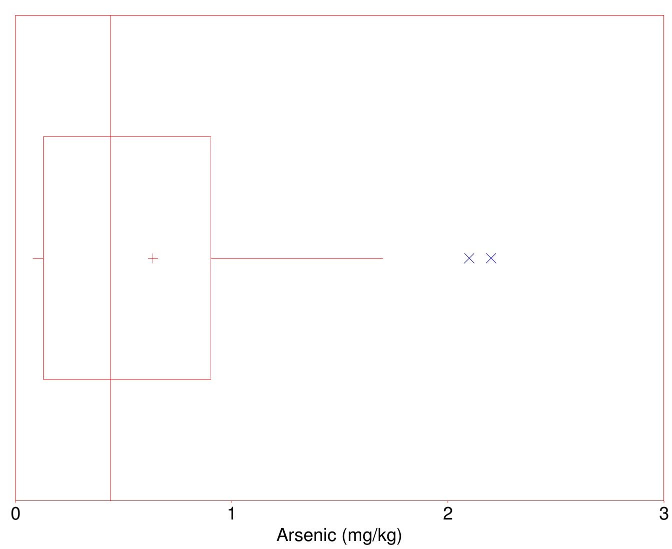
Data Plots for Arsenic
Graphical displays of the data are shown below.

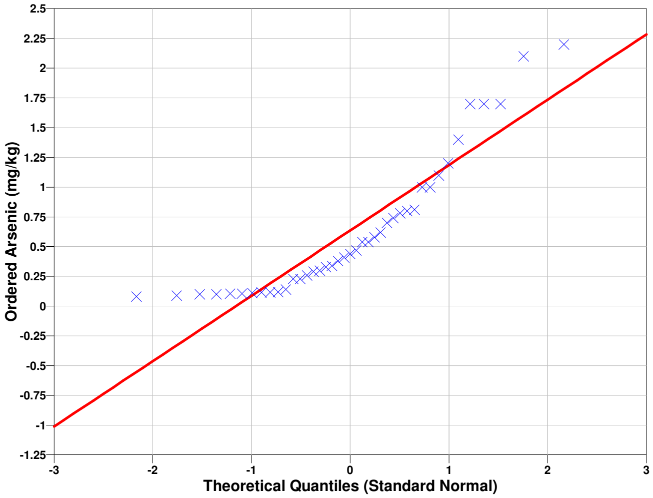
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Arsenic
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8361
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.7893
95% Non-Parametric (Chebyshev) UCL	1.033

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (1.033) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
2.7012	1.6839	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
19	26	Cannot Reject
Note: There may not be enough data to reject the null hypothesis (and conclude site is clean) with 95% confidence using the MARSSIM sign test.		

Data Analysis for Barium
The following data points were entered by the user for analysis.

Barium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	4.2	4.6	5.4	6.7	7.4	7.7	8.5	8.6	9.6	10.2
10	11.4	11.5	11.8	12	12.4	13.5	16.3	21.5	23.1	23.5
20	25	25.1	25.2	26.4	26.5	29.3	31.1	36.2	39.1	39.6
30	41.8	47.2	47.5	50.6	52.4	59.7	66.9	77.7	78.7	97.8
40	98.7									

SUMMARY STATISTICS for Barium	
n	41
Min	4.2
Max	98.7
Range	94.5
Mean	30.546
Median	25
Variance	641.13
StdDev	25.321
Std Error	3.9544
Skewness	1.2462
Interquartile Range	33.7

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**

4.2	4.68	6.84	10.8	25	44.5	75.54	95.89	98.7

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Barium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.692	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8687
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

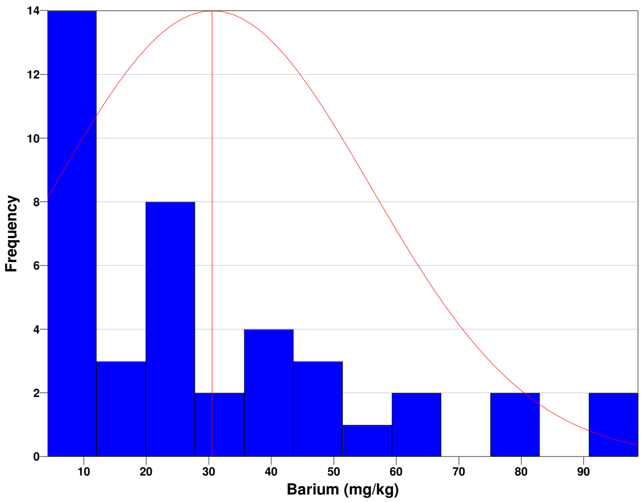
Data Plots for Barium
Graphical displays of the data are shown below.

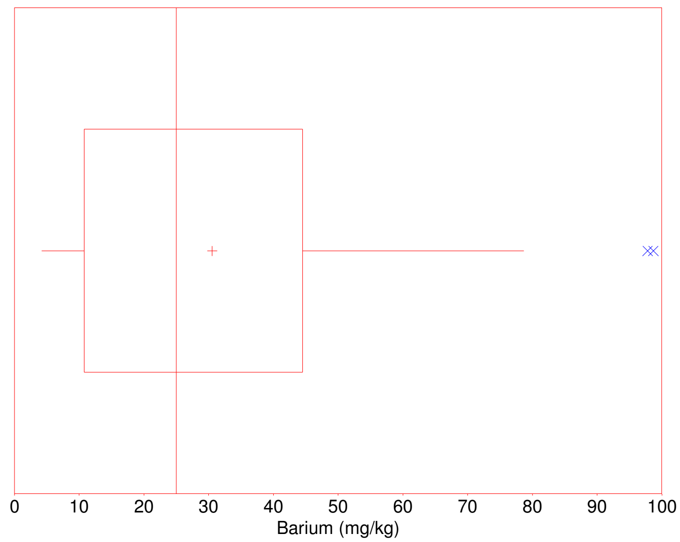
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

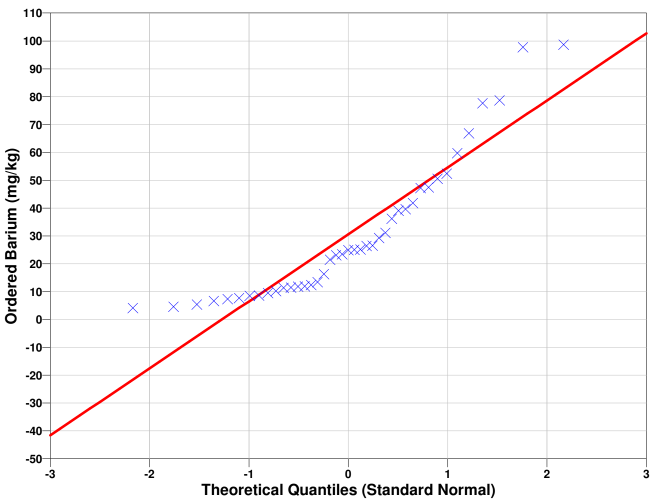
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a

fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Barium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8521
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN

95% Parametric UCL	37.2
95% Non-Parametric (Chebyshev) UCL	47.78

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (47.78) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1975	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Beryllium
The following data points were entered by the user for analysis.

Beryllium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.009	0.0115	0.0115	0.012	0.013	0.014	0.023	0.023	0.035	0.035
10	0.041	0.042	0.044	0.0445	0.047	0.054	0.064	0.064	0.067	0.086
20	0.097	0.1	0.1	0.1	0.11	0.11	0.11	0.12	0.13	0.13
30	0.15	0.15	0.19	0.21	0.25	0.27	0.28	0.29	0.3	0.32
40	0.42									

SUMMARY STATISTICS for Beryllium	
n	41
Min	0.009

Max				0.42				
Range				0.411				
Mean				0.11409				
Median				0.097				
Variance				0.010478				
StdDev				0.10236				
Std Error				0.015986				
Skewness				1.2312				
Interquartile Range				0.112				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.009	0.0115	0.0122	0.038	0.097	0.15	0.288	0.318	0.42

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Beryllium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.989	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8565
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

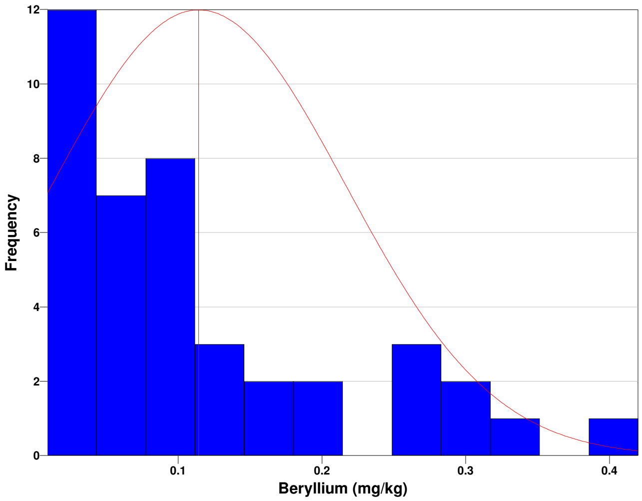
Data Plots for Beryllium
Graphical displays of the data are shown below.

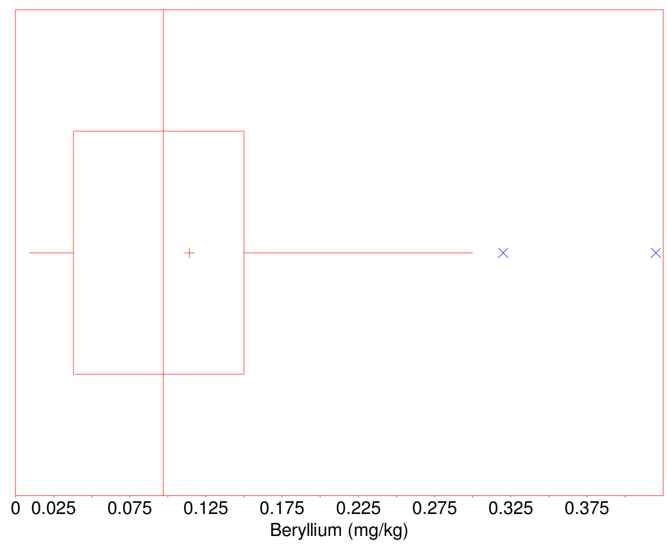
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The

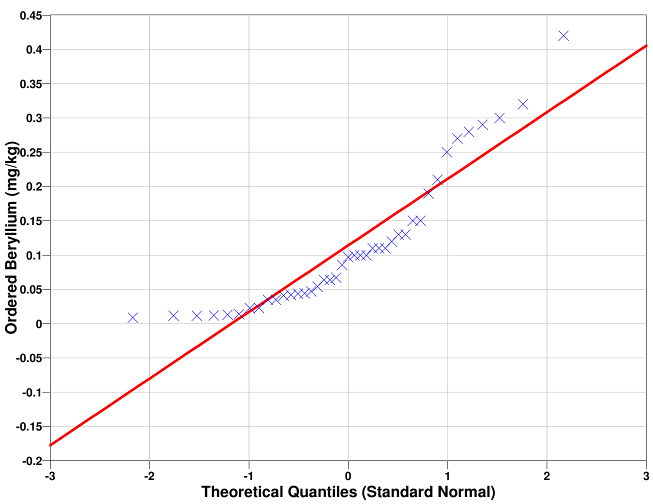
sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Beryllium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution.

The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8553
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.141
95% Non-Parametric (Chebyshev) UCL	0.1838

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.1838) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-2342.7	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Carbon Disulfide
The following data points were entered by the user for analysis.

Carbon Disulfide (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00065	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007
10	0.0007	0.0007	0.0007	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075
20	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.0008
30	0.0008	0.0008	0.0008	0.00085	0.00155	0.0016	0.002	0.0021	0.0023	0.0025
40	0.0041									

SUMMARY STATISTICS for Carbon Disulfide	
n	41
Min	0.00065
Max	0.0041
Range	0.00345
Mean	0.0010061
Median	0.00075
Variance	4.7015e-007
StdDev	0.00068567
Std Error	0.00010708
Skewness	3.0231
Interquartile Range	0.0001

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00065	0.0007	0.0007	0.0007	0.00075	0.0008	0.00208	0.00248	0.0041

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Carbon Disulfide			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.512	3.05	Yes

The test statistic 4.512 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Carbon Disulfide	
1	0.0041

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is

recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5218
Shapiro-Wilk 5% Critical Value	0.94

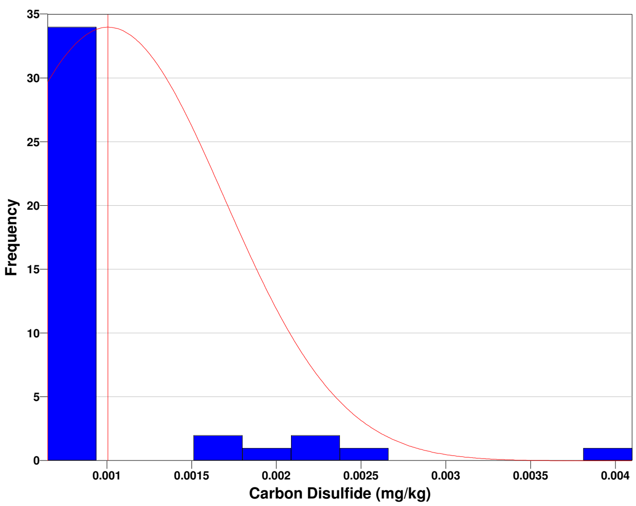
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

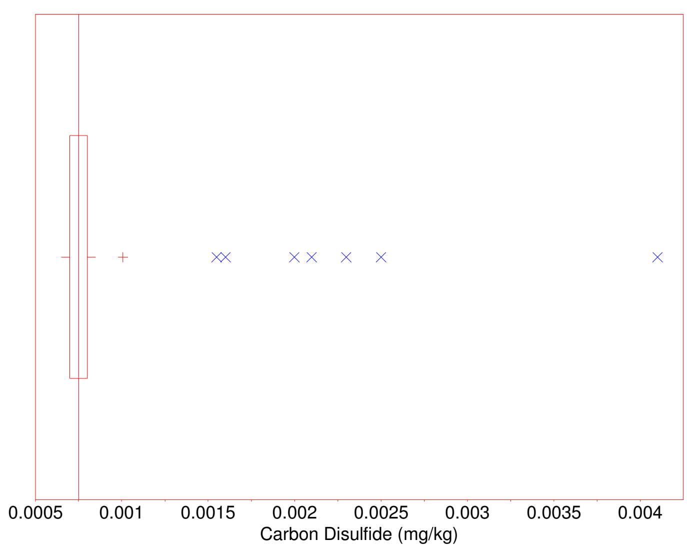
Data Plots for Carbon Disulfide
Graphical displays of the data are shown below.

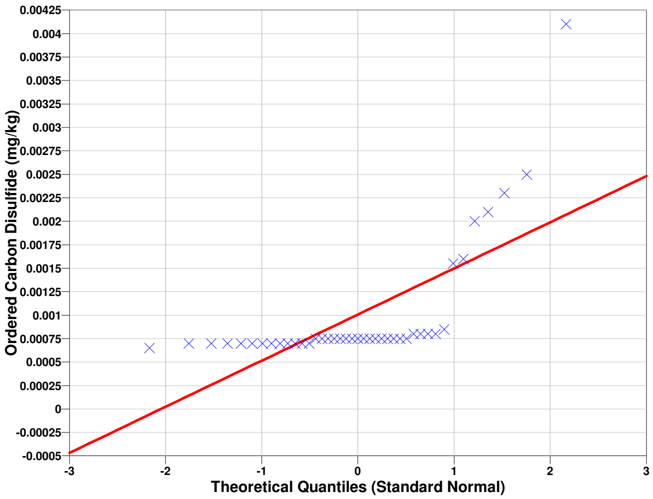
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Carbon Disulfide
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5151
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.001186
95% Non-Parametric (Chebyshev) UCL	0.001473

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.001473) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-6.7354e+006	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Chromium
The following data points were entered by the user for analysis.

Chromium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.58	0.59	0.6	0.63	0.76	0.8	0.98	1	1.2	1.2
10	1.4	1.5	1.7	1.8	1.8	1.9	2.1	2.2	2.2	2.3
20	2.4	2.5	2.5	2.7	2.9	3.2	3.2	3.4	3.5	3.7
30	3.7	3.9	4.1	4.3	4.9	5.2	6	6.1	7.4	8.8
40	15									

SUMMARY STATISTICS for Chromium								
n	41							
Min	0.58							
Max	15							
Range	14.42							
Mean	3.0888							
Median	2.4							
Variance	7.2627							
StdDev	2.6949							
Std Error	0.42088							
Skewness	2.5355							
Interquartile Range	2.5							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.58	0.591	0.656	1.3	2.4	3.8	6.08	8.66	15

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Chromium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.42	3.05	Yes

The test statistic 4.42 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Chromium	
1	15

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8953
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

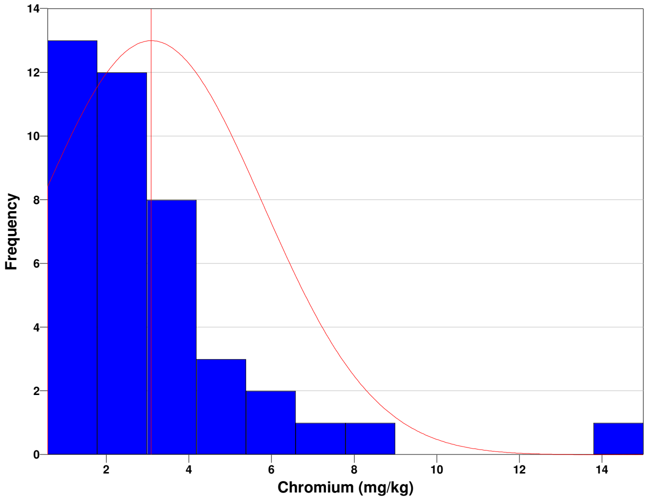
Data Plots for Chromium
Graphical displays of the data are shown below.

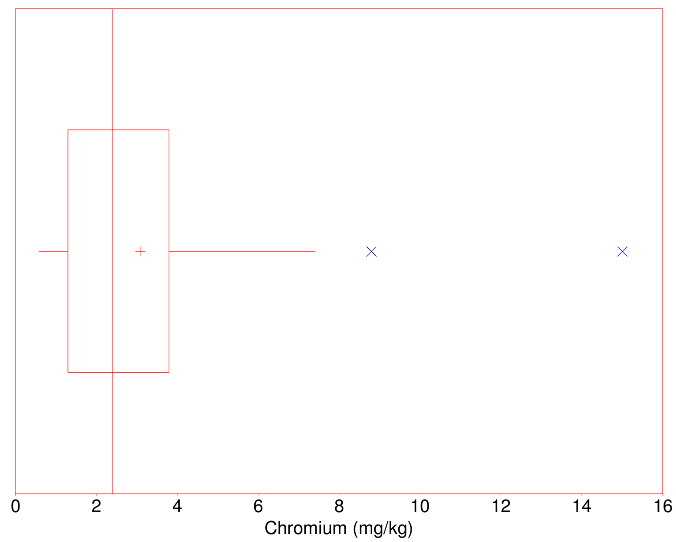
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

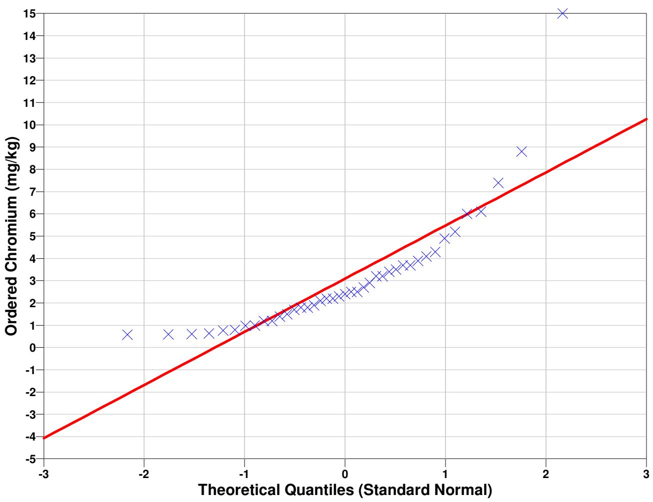
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the

Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Chromium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7725
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	3.797
95% Non-Parametric (Chebyshev) UCL	4.923

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (4.923) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-493.22	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Chromium_ Hexavalent
The following data points were entered by the user for analysis.

Chromium_ Hexavalent (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.55	0.55
10	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
20	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.65	0.65	0.65
30	0.65	0.65	0.65	0.65	0.7	0.7	1.1	1.2	1.3	1.3
40	1.6									

SUMMARY STATISTICS for Chromium_ Hexavalent	
n	41

Min				0.5				
Max				1.6				
Range				1.1				
Mean				0.67683				
Median				0.6				
Variance				0.061762				
StdDev				0.24852				
Std Error				0.038812				
Skewness				2.4548				
Interquartile Range				0.075				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.5	0.5	0.5	0.575	0.6	0.65	1.18	1.3	1.6

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Chromium_ Hexavalent			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.715	3.05	Yes

The test statistic 3.715 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Chromium_ Hexavalent	
1	1.6

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6004
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

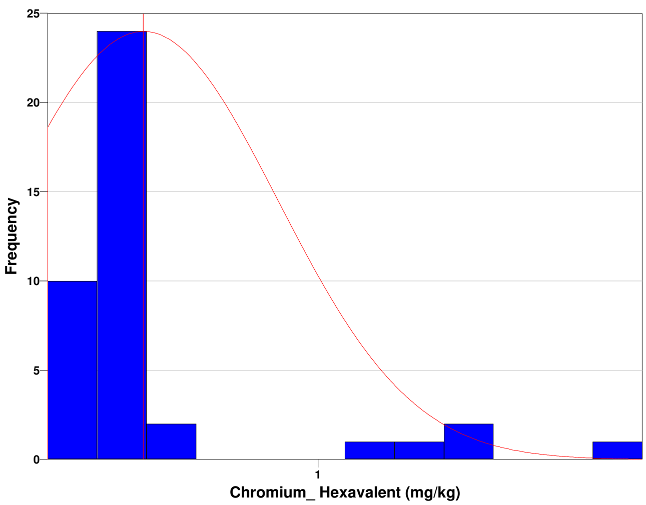
Data Plots for Chromium_ Hexavalent

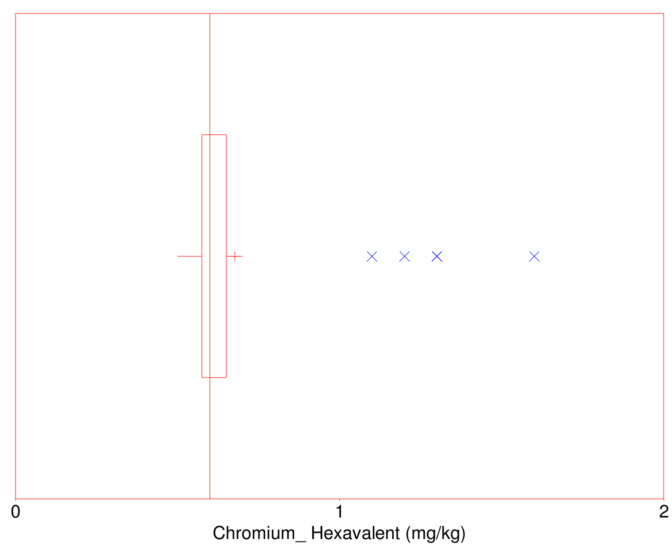
Graphical displays of the data are shown below.

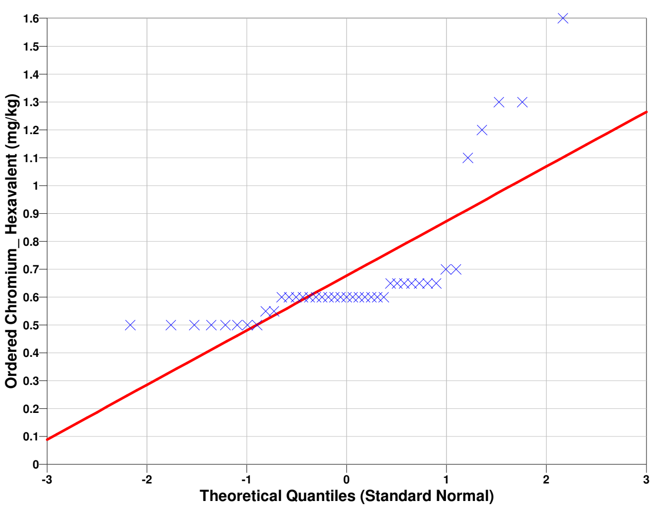
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Chromium_ Hexavalent
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6066
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.7422
95% Non-Parametric (Chebyshev) UCL	0.846

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.846) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-758	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**

41	26	Reject

Data Analysis for Cobalt
The following data points were entered by the user for analysis.

Cobalt (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.07	0.08	0.09	0.09	0.095	0.095	0.095	0.1	0.1	0.105
10	0.11	0.125	0.24	0.25	0.26	0.31	0.34	0.35	0.39	0.44
20	0.48	0.5	0.55	0.56	0.56	0.58	0.58	0.61	0.69	0.715
30	0.72	0.73	0.78	0.84	0.99	1.1	1.2	1.5	1.7	1.9
40	1.9									

SUMMARY STATISTICS for Cobalt								
n	41							
Min	0.07							
Max	1.9							
Range	1.83							
Mean	0.55902							
Median	0.48							
Variance	0.24915							
StdDev	0.49914							
Std Error	0.077953							
Skewness	1.3458							
Interquartile Range	0.6175							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.07	0.081	0.091	0.1075	0.48	0.725	1.44	1.88	1.9

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Cobalt			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.687	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8517
Shapiro-Wilk 5% Critical Value	0.94

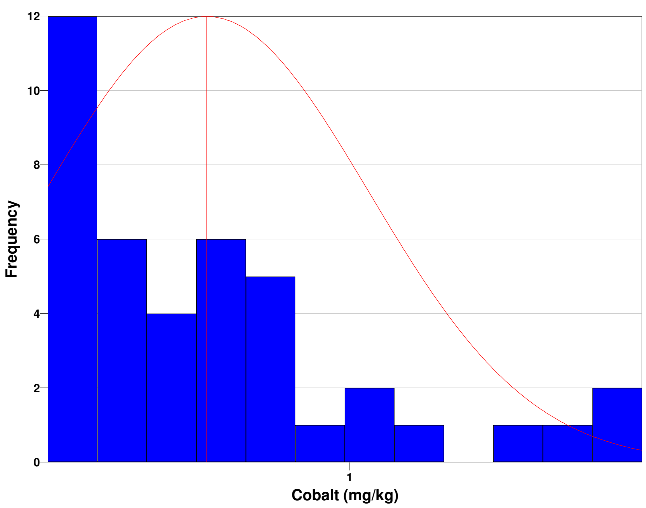
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

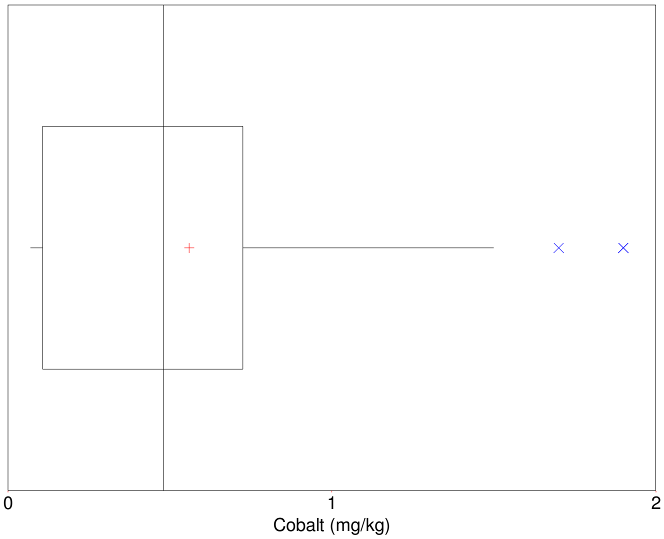
Data Plots for Cobalt
Graphical displays of the data are shown below.

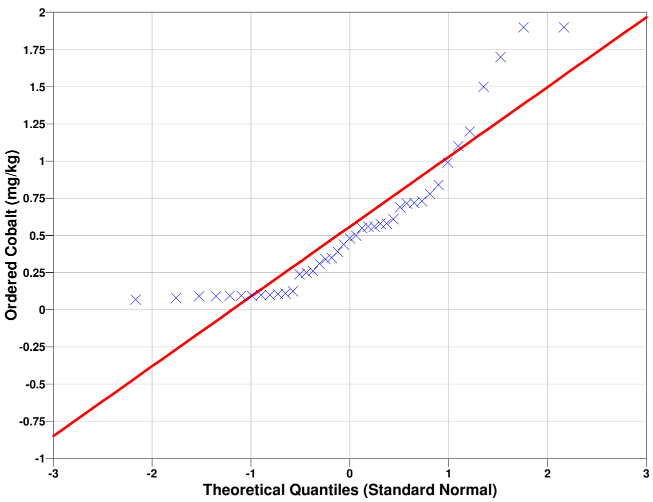
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Cobalt
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.835
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.6903

95% Non-Parametric (Chebyshev) UCL	0.8988

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.8988) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-11575	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Copper
The following data points were entered by the user for analysis.

Copper (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.35	0.39	0.39	0.44	0.45	0.47	0.48	0.49	0.58	0.59
10	0.61	0.62	0.72	0.725	0.79	0.89	0.9	0.92	0.96	1
20	1.1	1.1	1.2	1.2	1.3	1.3	1.5	1.6	1.7	1.8
30	1.9	1.9	1.9	2	2.1	2.4	3.8	3.9	4.1	4.4
40	5.9									

SUMMARY STATISTICS for Copper	
n	41
Min	0.35
Max	5.9

Range	5.55
Mean	1.4845
Median	1.1
Variance	1.5972
StdDev	1.2638
Std Error	0.19737
Skewness	1.8525
Interquartile Range	1.3

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.35	0.39	0.442	0.6	1.1	1.9	3.88	4.37	5.9

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Copper			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.494	3.05	Yes

The test statistic 3.494 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Copper	
1	5.9

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8002
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

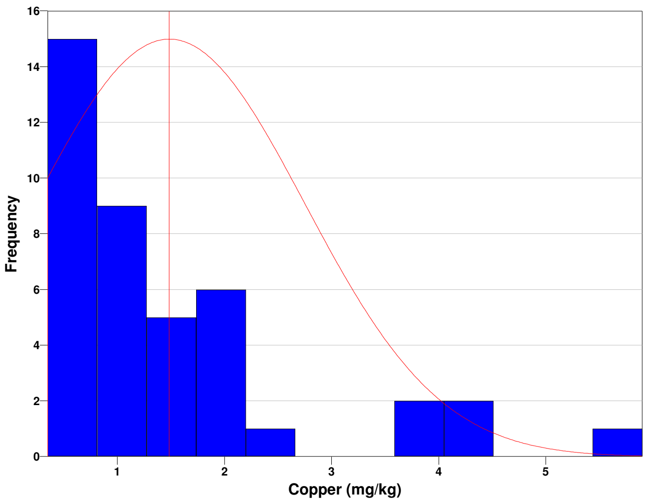
Data Plots for Copper
Graphical displays of the data are shown below.

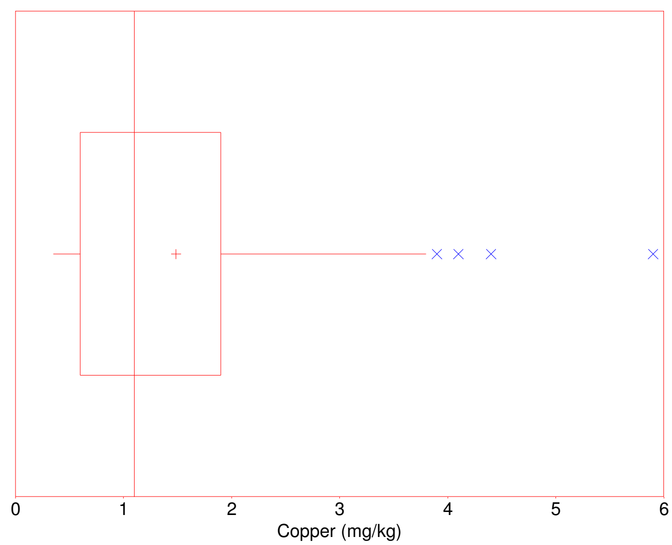
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

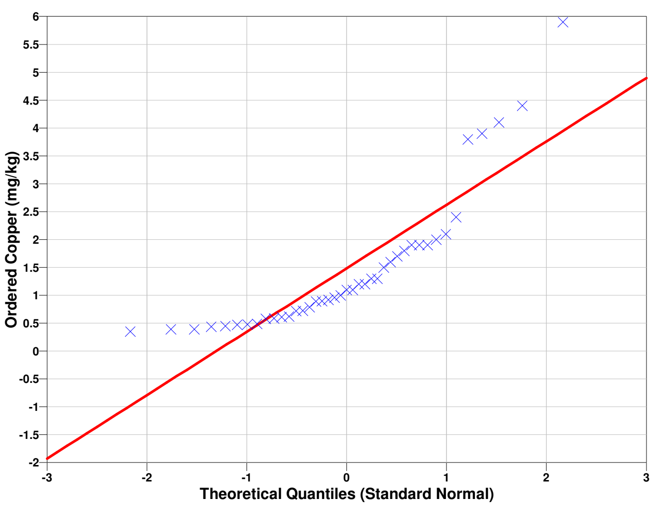
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Copper
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7798
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	1.817
95% Non-Parametric (Chebyshev) UCL	2.345

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (2.345) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-2766.9	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Diethyl phthalate
The following data points were entered by the user for analysis.

Diethyl phthalate (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.024	0.026	0.026	0.026	0.0265	0.0265	0.0265	0.0265	0.027	0.027
10	0.027	0.027	0.027	0.027	0.027	0.027	0.0275	0.0275	0.0275	0.0275
20	0.0275	0.0275	0.028	0.0285	0.0285	0.0285	0.0285	0.029	0.029	0.0295
30	0.0295	0.0305	0.031	0.0315	0.0763	0.0952	0.101	0.111	0.12	0.123
40	0.31									

SUMMARY STATISTICS for Diethyl phthalate								
n	41							
Min	0.024							
Max	0.31							
Range	0.286							
Mean	0.045793							
Median	0.0275							
Variance	0.0025795							
StdDev	0.050789							
Std Error	0.0079319							
Skewness	3.952							
Interquartile Range	0.003							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.024	0.026	0.0261	0.027	0.0275	0.03	0.109	0.1227	0.31

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Diethyl phthalate			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.202	3.05	Yes

The test statistic 5.202 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Diethyl phthalate

1	0.31

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.4949
Shapiro-Wilk 5% Critical Value	0.94

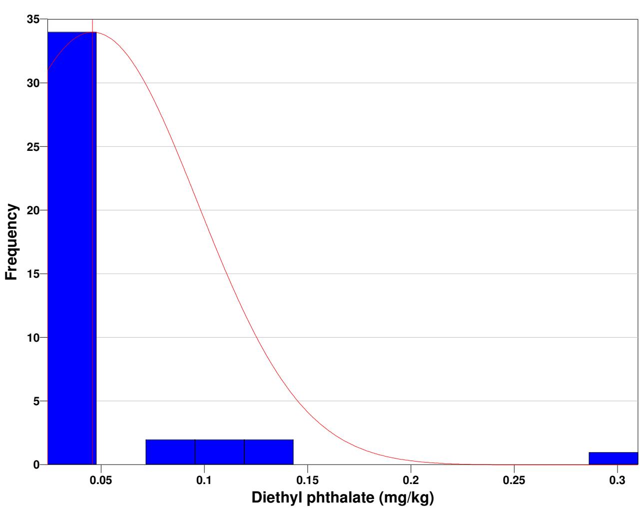
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

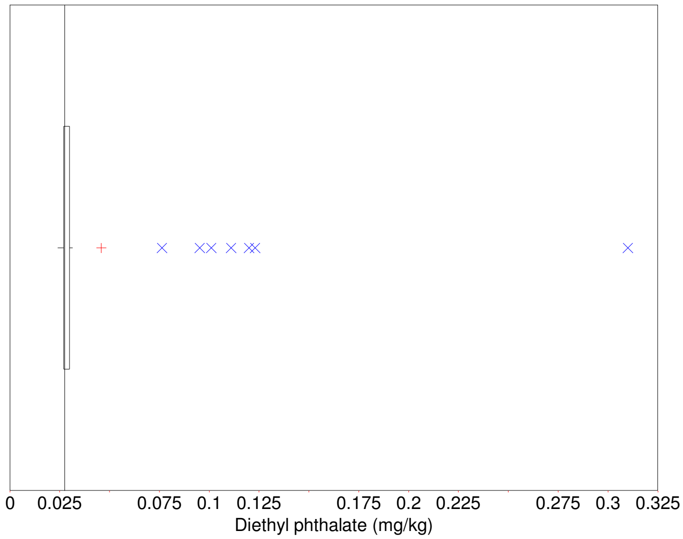
Data Plots for Diethyl phthalate
Graphical displays of the data are shown below.

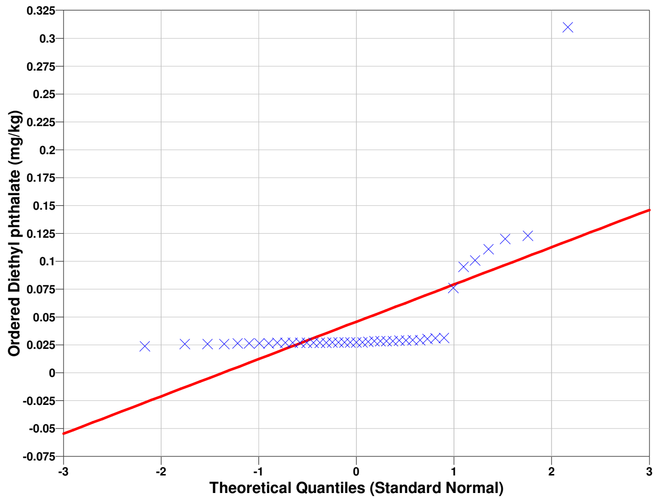
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Diethyl phthalate
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.4472
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.05915

95% Non-Parametric (Chebyshev) UCL	0.08037

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.08037) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.7957e+005	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Lead
The following data points were entered by the user for analysis.

Lead (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1.3	1.5	1.5	1.6	1.7	1.7	1.8	1.9	1.9	1.9
10	2	2.1	2.15	2.3	2.3	2.3	2.3	2.4	2.5	2.6
20	2.7	2.7	2.7	2.8	3.1	3.2	3.2	3.5	3.6	3.8
30	4.1	4.2	4.2	4.3	5.7	5.9	6	6.3	6.8	9.3
40	26									

SUMMARY STATISTICS for Lead	
n	41
Min	1.3
Max	26

Range	24.7
Mean	3.7524
Median	2.7
Variance	15.65
StdDev	3.956
Std Error	0.61782
Skewness	4.7237
Interquartile Range	2.2

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
1.3	1.5	1.62	1.95	2.7	4.15	6.24	9.05	26

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Lead			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.624	3.05	Yes

The test statistic 5.624 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Lead	
1	26

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.835
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

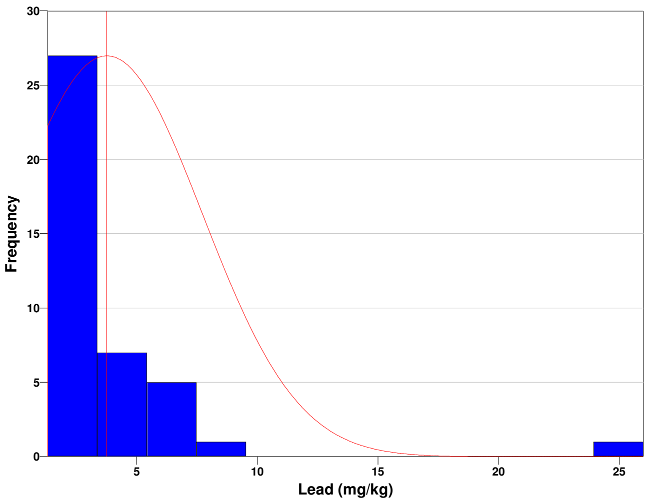
Data Plots for Lead
Graphical displays of the data are shown below.

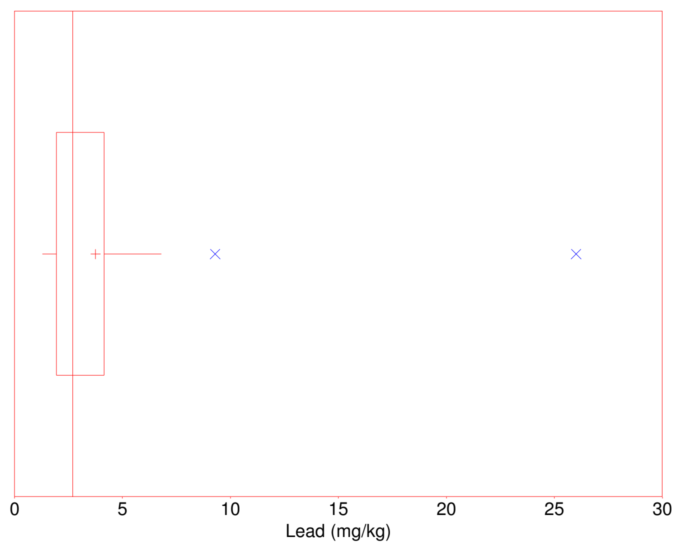
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

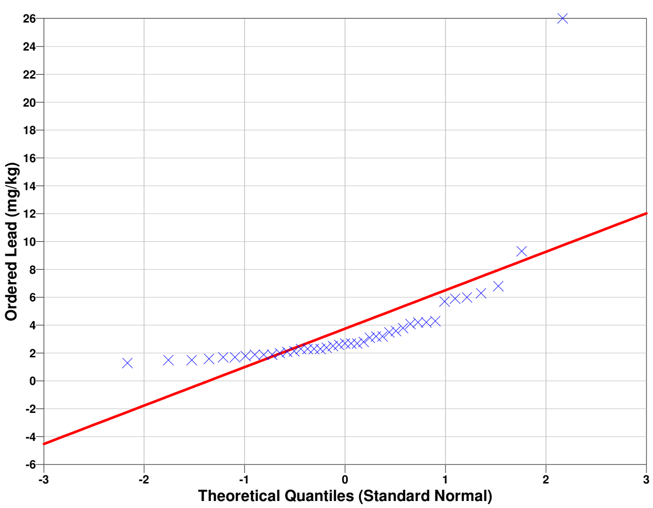
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Lead
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5047
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	4.793
95% Non-Parametric (Chebyshev) UCL	6.445

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (6.445) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-641.36	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Manganese
The following data points were entered by the user for analysis.

Manganese (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	2.7	3.1	3.5	4.1	4.4	4.5	4.6	5.1	5.5	6.2
10	7.5	9	9.1	9.9	9.9	10.1	10.8	11.9	12.9	13.9
20	17.2	17.8	19.7	21.3	29	31.7	36	49.3	51.3	54.3
30	69.5	70.1	73	75	76.3	112	130	134	146	153
40	241									

SUMMARY STATISTICS for Manganese								
n	41							
Min	2.7							
Max	241							
Range	238.3							
Mean	42.834							
Median	17.2							
Variance	2886.1							
StdDev	53.723							
Std Error	8.3901							
Skewness	1.8878							
Interquartile Range	62.95							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
2.7	3.14	4.16	6.85	17.2	69.8	133.2	152.3	241

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Manganese			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.689	3.05	Yes

The test statistic 3.689 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Manganese

1	241

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7607
Shapiro-Wilk 5% Critical Value	0.94

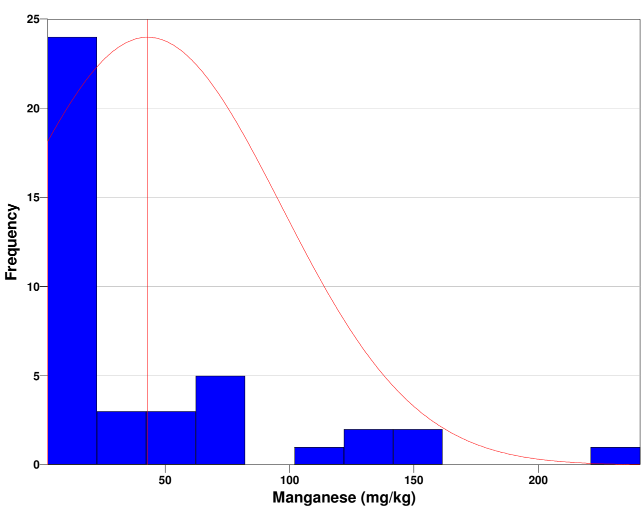
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

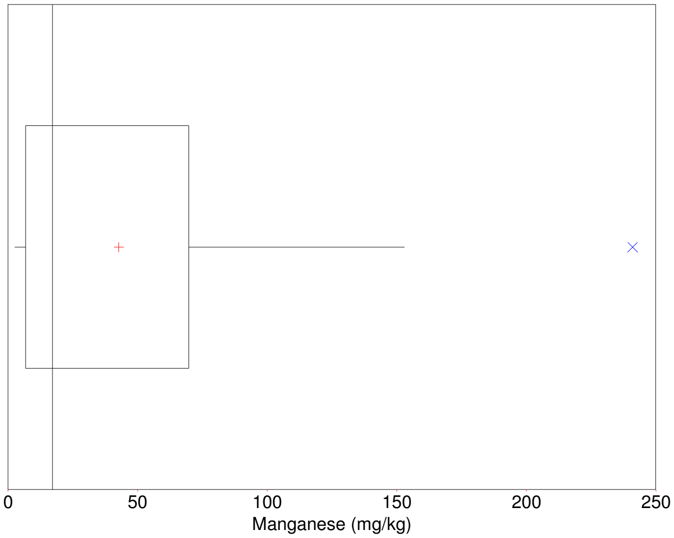
Data Plots for Manganese
Graphical displays of the data are shown below.

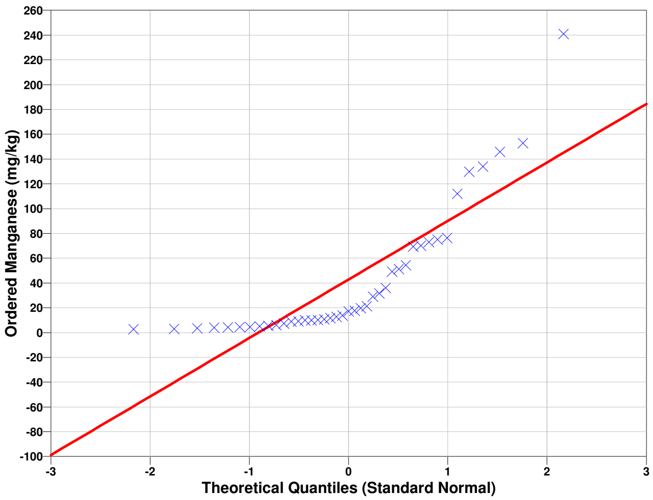
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Manganese
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7451
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	56.96

95% Non-Parametric (Chebyshev) UCL	79.41

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (79.41) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-380.98	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Mercury
The following data points were entered by the user for analysis.

Mercury (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00035	0.00036	0.000365	0.00038	0.00038	0.00038	0.000385	0.00043	0.00044	0.0013
10	0.0017	0.0021	0.0024	0.0025	0.0026	0.0038	0.0043	0.0045	0.0046	0.0048
20	0.0048	0.0051	0.0053	0.0065	0.0072	0.0073	0.0077	0.008	0.01	0.011
30	0.012	0.012	0.013	0.014	0.019	0.033	0.048	0.054	0.055	0.055
40	0.59									

SUMMARY STATISTICS for Mercury	
n	41
Min	0.00035
Max	0.59

Range				0.58965				
Mean				0.02478				
Median				0.0048				
Variance				0.0084248				
StdDev				0.091787				
Std Error				0.014335				
Skewness				6.13				
Interquartile Range				0.0105				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00035	0.0003605	0.00038	0.0015	0.0048	0.012	0.0528	0.055	0.59

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Mercury			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	6.158	3.05	Yes

The test statistic 6.158 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Mercury	
1	0.59

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6364
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

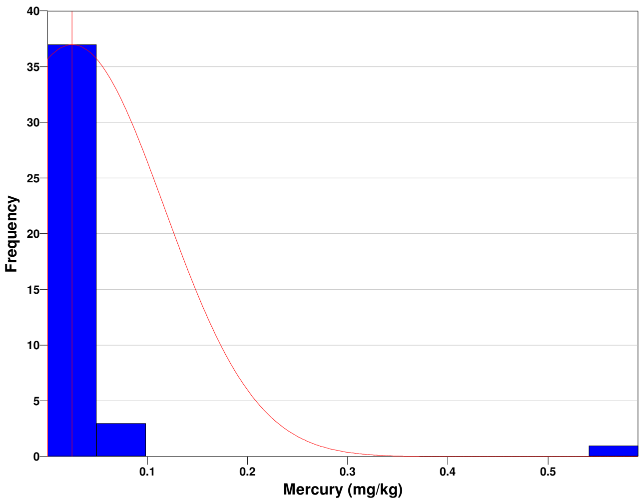
Data Plots for Mercury
Graphical displays of the data are shown below.

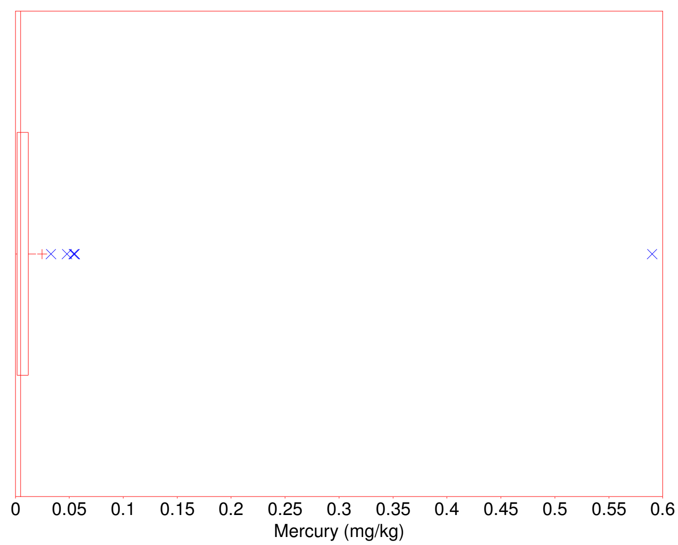
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

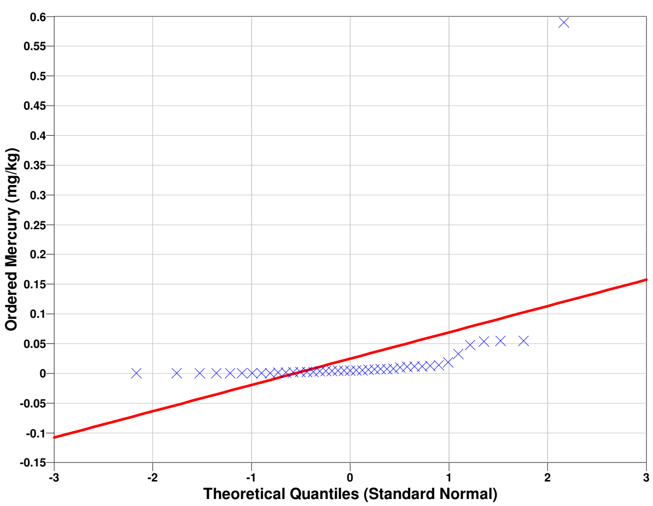
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Mercury
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.2612
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.04892
95% Non-Parametric (Chebyshev) UCL	0.08726

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.08726) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-143.88	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Methylene chloride
The following data points were entered by the user for analysis.

Methylene chloride (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00135	0.00135	0.00135	0.00135	0.00135	0.0014	0.0014	0.0014	0.00145	0.00145
10	0.00145	0.00145	0.00145	0.00145	0.00145	0.0015	0.0015	0.003	0.0031	0.0031
20	0.0034	0.0034	0.0039	0.0042	0.0044	0.0044	0.0048	0.0049	0.0053	0.0058
30	0.006	0.0072	0.0076	0.0078	0.0078	0.0101	0.0143	0.0146	0.016	0.0334
40	0.0999									

SUMMARY STATISTICS for Methylene chloride	
n	41
Min	0.00135
Max	0.0999
Range	0.09855
Mean	0.007378
Median	0.0034
Variance	0.00025431
StdDev	0.015947
Std Error	0.0024905
Skewness	5.2288
Interquartile Range	0.00515

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00135	0.00135	0.00135	0.00145	0.0034	0.0066	0.01454	0.03166	0.0999

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Methylene chloride			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.802	3.05	Yes

The test statistic 5.802 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Methylene chloride

1	0.0999

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6434
Shapiro-Wilk 5% Critical Value	0.94

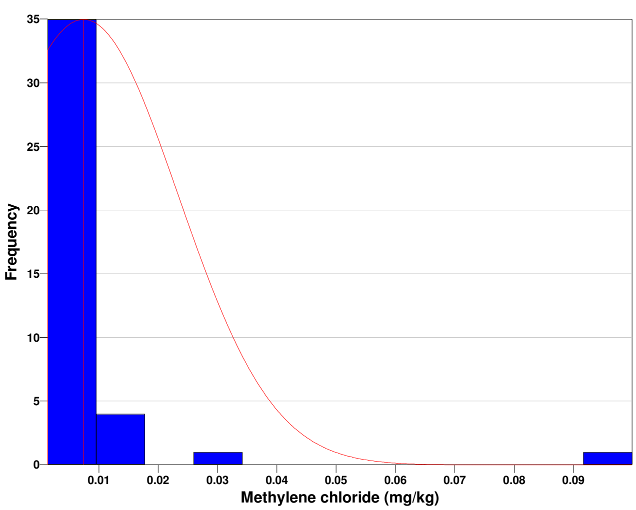
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

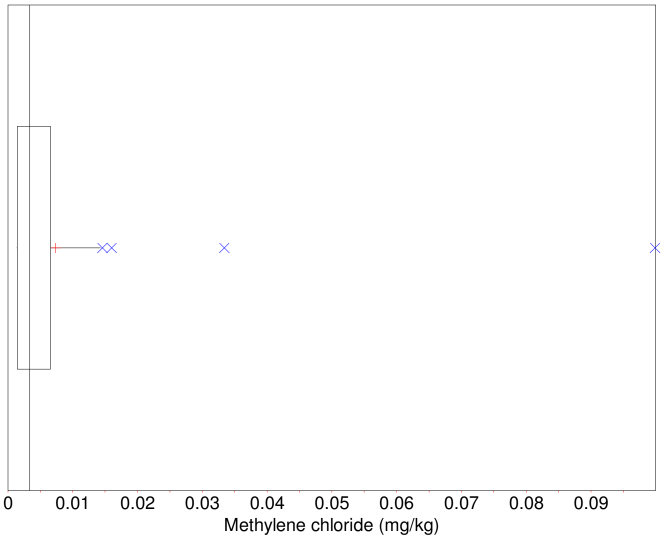
Data Plots for Methylene chloride
Graphical displays of the data are shown below.

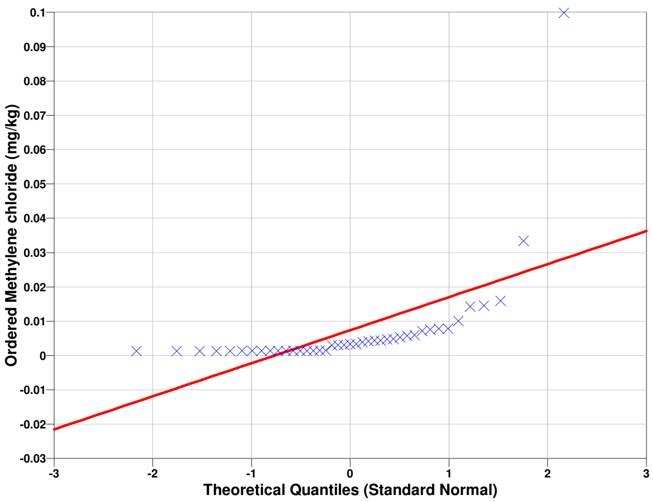
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Methylene chloride
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.3879
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.01157

95% Non-Parametric (Chebyshev) UCL	0.01823

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.01823) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-503.41	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Nickel
The following data points were entered by the user for analysis.

Nickel (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.06	0.065	0.08	0.18	0.21	0.22	0.22	0.23	0.26	0.26
10	0.28	0.29	0.32	0.36	0.36	0.39	0.46	0.66	0.73	0.99
20	1	1.1	1.3	1.3	1.4	1.4	1.4	1.5	1.5	1.8
30	1.8	1.8	1.8	1.8	2.4	2.6	2.9	3.6	4	5.8
40	5.9									

SUMMARY STATISTICS for Nickel	
n	41
Min	0.06
Max	5.9

Range	5.84
Mean	1.3348
Median	1
Variance	2.0169
StdDev	1.4202
Std Error	0.2218
Skewness	1.8288
Interquartile Range	1.53

Percentiles

1%	5%	10%	25%	50%	75%	90%	95%	99%
0.06	0.0665	0.186	0.27	1	1.8	3.46	5.62	5.9

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Nickel

k	Test Statistic R_k	5% Critical Value C_k	Significant?
1	3.215	3.05	Yes

The test statistic 3.215 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Nickel	
1	5.9

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8158
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

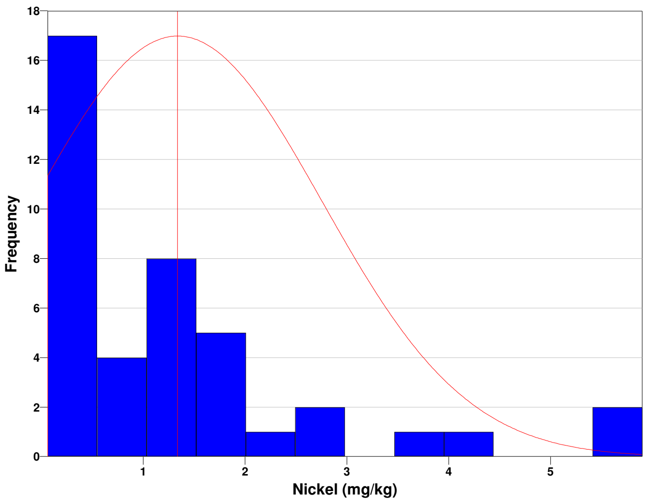
Data Plots for Nickel
Graphical displays of the data are shown below.

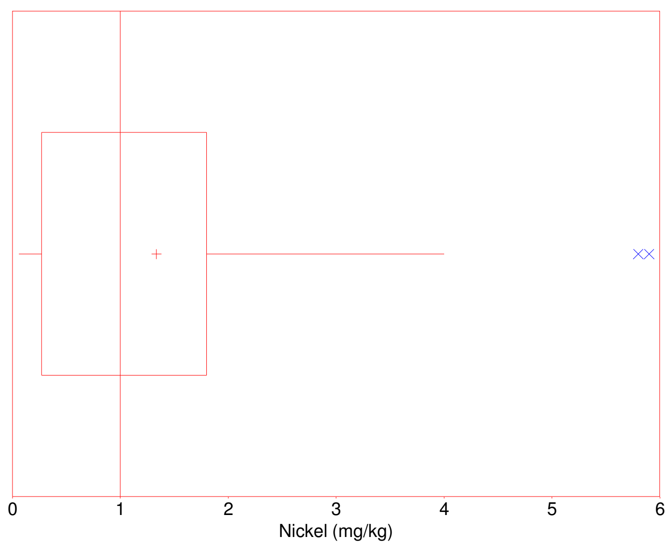
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

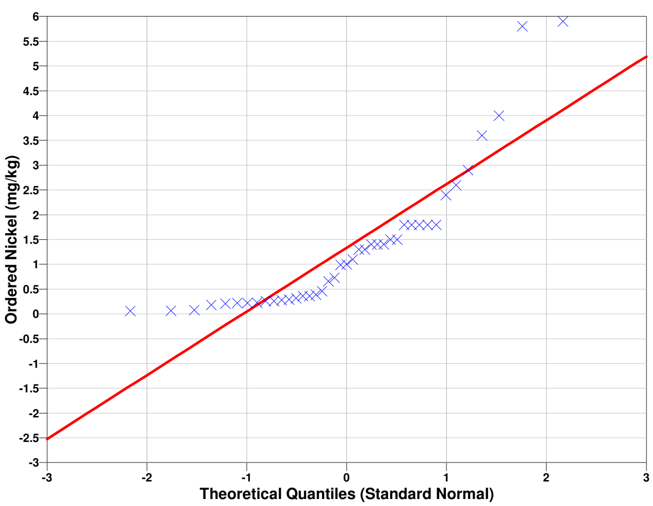
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Nickel
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.784
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	1.708
95% Non-Parametric (Chebyshev) UCL	2.302

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (2.302) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-3745.6	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Vanadium
The following data points were entered by the user for analysis.

Vanadium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.65	0.77	0.83	0.89	0.95	0.97	1	1.1	1.2	1.3
10	1.7	1.7	1.8	1.95	2	2.1	2.3	2.4	2.4	2.4
20	2.9	3.1	3.2	3.6	3.7	3.8	4.3	4.4	4.5	5
30	5.3	5.7	5.8	6	6.7	6.9	7.1	11	12.1	13
40	13.7									

SUMMARY STATISTICS for Vanadium	
n	41
Min	0.65
Max	13.7
Range	13.05
Mean	3.9563
Median	2.9
Variance	11.535
StdDev	3.3963
Std Error	0.53042
Skewness	1.5509
Interquartile Range	4

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.65	0.776	0.902	1.5	2.9	5.5	10.22	12.91	13.7

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Vanadium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.869	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the

suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8286
Shapiro-Wilk 5% Critical Value	0.94

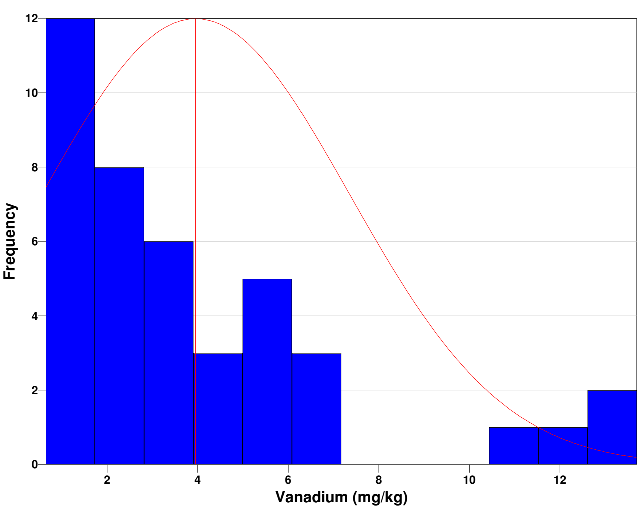
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

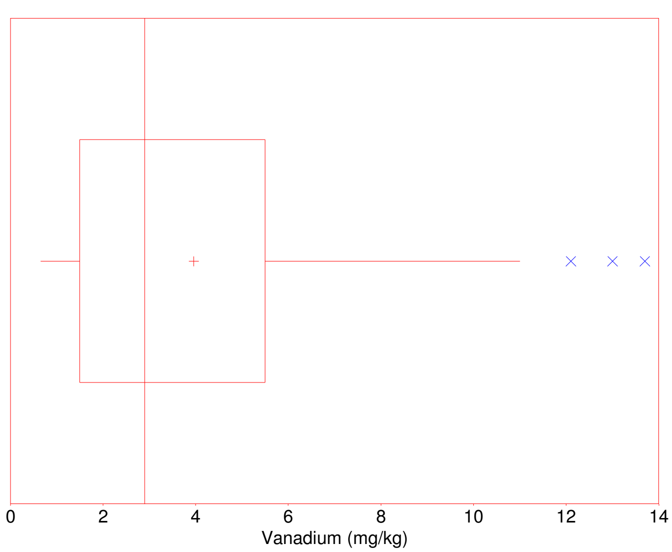
Data Plots for Vanadium
Graphical displays of the data are shown below.

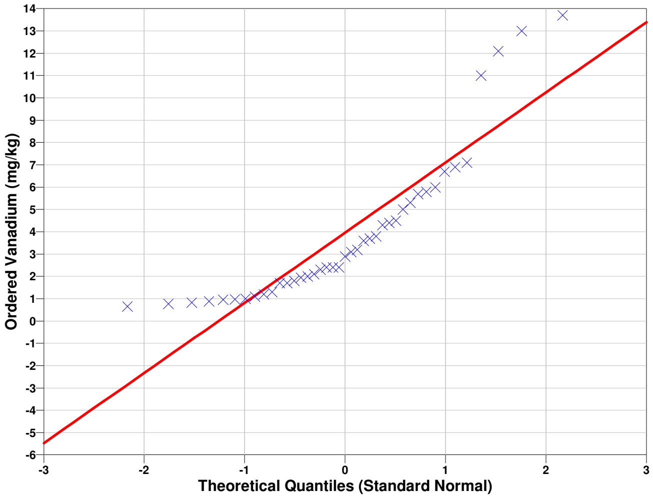
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Vanadium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8131
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	4.849
95% Non-Parametric (Chebyshev) UCL	6.268

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (6.268) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test

A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where

x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-541.19	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Xylene (total)
The following data points were entered by the user for analysis.

Xylene (total) (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00195	0.00205	0.00205	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021
10	0.0021	0.00215	0.00215	0.00215	0.00215	0.0022	0.0022	0.0022	0.0022	0.0022
20	0.0022	0.0022	0.0022	0.0022	0.00223	0.00225	0.00225	0.0023	0.0023	0.0023
30	0.0023	0.00235	0.0024	0.0024	0.0024	0.00255	0.0045	0.0049	0.0064	0.0119
40	0.0217									

SUMMARY STATISTICS for Xylene (total)								
n	41							
Min	0.00195							
Max	0.0217							
Range	0.01975							
Mean	0.0031385							
Median	0.0022							
Variance	1.1724e-005							
StdDev	0.003424							
Std Error	0.00053474							
Skewness	4.6349							
Interquartile Range	0.000225							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00195	0.00205	0.0021	0.0021	0.0022	0.002325	0.00482	0.01135	0.0217

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Xylene (total)			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.421	3.05	Yes

The test statistic 5.421 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Xylene (total)	
1	0.0217

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.3814
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

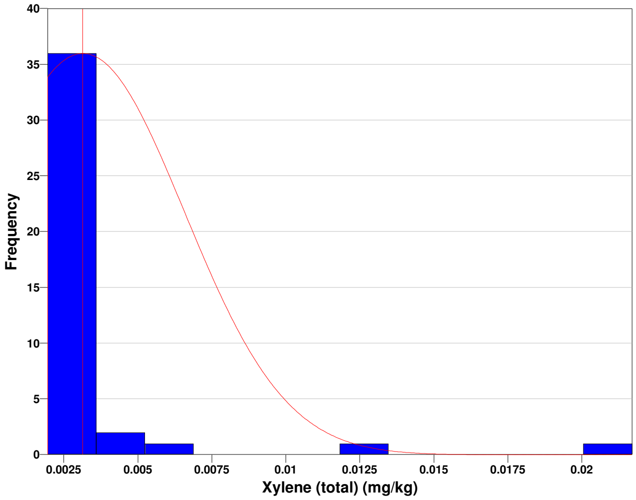
Data Plots for Xylene (total)
Graphical displays of the data are shown below.

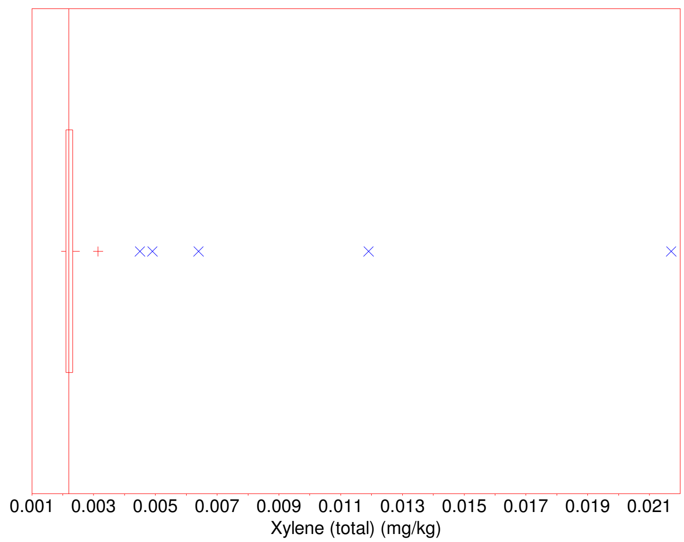
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

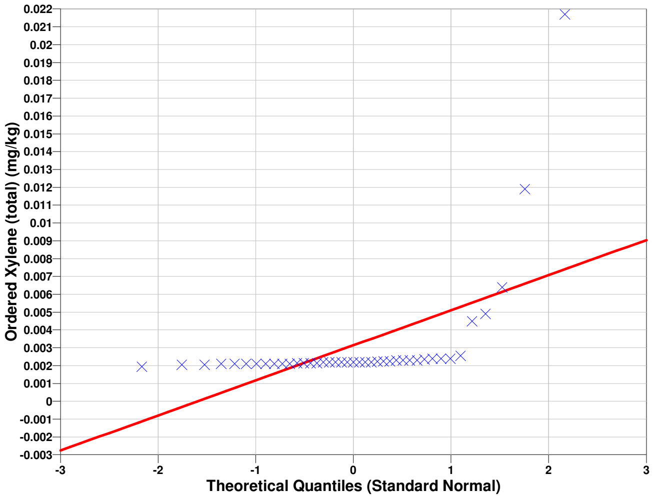
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the

Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Xylene (total)
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.3502
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.004039
95% Non-Parametric (Chebyshev) UCL	0.005469

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.005469) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-4.0109e+005	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Zinc
The following data points were entered by the user for analysis.

Zinc (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1.5	1.5	1.6	1.6	2.1	2.2	2.3	2.3	2.8	2.8
10	2.9	3.1	3.1	3.2	3.6	4.4	4.4	5.4	5.7	6.4
20	6.5	6.7	7	7	7.1	7.2	7.3	7.3	7.4	8.1
30	8.3	10.3	10.3	11	11	15	16.6	18.9	19.5	23.6
40	24.8									

SUMMARY STATISTICS for Zinc	
n	41

Min	1.5
Max	24.8
Range	23.3
Mean	7.4098
Median	6.5
Variance	35.841
StdDev	5.9867
Std Error	0.93497
Skewness	1.486
Interquartile Range	6.45

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
1.5	1.51	1.7	2.85	6.5	9.3	18.44	23.19	24.8

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Zinc			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.905	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8409
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

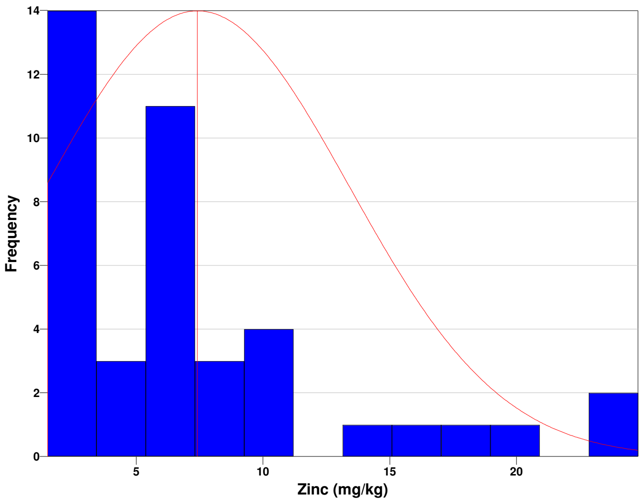
Data Plots for Zinc
Graphical displays of the data are shown below.

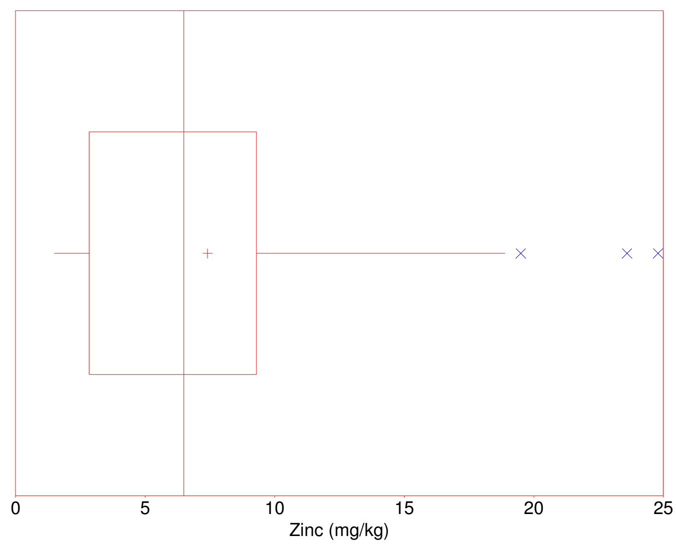
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each

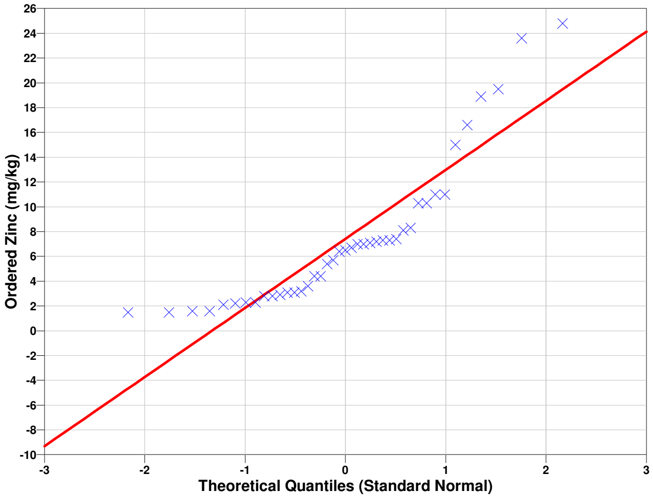
bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Zinc
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.823
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	8.984
95% Non-Parametric (Chebyshev) UCL	11.49

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (11.49) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-10604	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Appendix C

VSP Reports of Calculated Minimum Sample Quantity
Report 6
Area of Concern – 1
Minimum Sample Quantity Calculation for Subsurface Soil using Human Health Benchmarks and Delta Method 2

Random sampling locations for comparing a mean with a fixed threshold (parametric)

Summary
This report summarizes the sampling design, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design for Arsenic, the driving analyte (the analyte which required the largest number of samples). A figure that shows sampling locations in the field and a table that lists sampling location coordinates are also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean to a fixed threshold
Type of Sampling Design	Parametric
Sample Placement (Location) in the Field	Simple random sampling
Working (Null) Hypothesis	The mean value at the site exceeds the threshold
Formula for calculating number of sampling locations	Student's t-test
Calculated total number of samples	79
Number of samples on map [a]	79
Number of selected sample areas [b]	1
Specified sampling area [c]	188054.34 m^2
Total cost of sampling [d]	$40,500.00

[a] This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[d] Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.

Area: Area 3					
X Coord	Y Coord	Label	Value	Type	Historical
679133.4290	3083306.3130	J-01S		Manual	T
679104.2450	3083223.2620	J-02S		Manual	T
679155.0740	3083294.6960	J-03S		Manual	T
679171.2970	3083289.7960	J-04S		Manual	T
679225.8560	3083359.9740	J-05S		Manual	T

679164.8060	3083214.7100	J-06S		Manual	T
679242.7260	3083326.5280	J-07S		Manual	T
679181.2750	3083178.2880	J-08S		Manual	T
679213.7730	3083224.9730	J-09S		Manual	T
679280.5440	3083305.6810	J-10S		Manual	T
679268.7700	3083200.3260	J-11S		Manual	T
679301.1600	3083254.0340	J-12S		Manual	T
679149.4920	3082933.0980	J-13S		Manual	T
679279.6830	3083075.4290	J-14S		Manual	T
679261.0980	3083016.3510	J-15S		Manual	T
679222.6340	3082840.1720	J-16S		Manual	T
679293.5600	3082950.4980	J-17S		Manual	T
679360.5700	3083026.4980	J-18S		Manual	T
679343.5810	3082969.5980	J-19S		Manual	T
679382.8640	3083009.1130	J-20S		Manual	T
679335.0020	3082941.1720	J-21S		Manual	T
679252.7130	3082781.0290	J-22S		Manual	T
679297.0010	3082840.6970	J-23S		Manual	T
679394.8070	3082971.8300	J-24S		Manual	T
679146.6460	3082549.7640	J-25S		Manual	T
679224.5850	3082683.1400	J-26S		Manual	T
679169.0760	3082537.3510	J-27S		Manual	T
679272.0040	3082652.6750	J-28S		Manual	T
679329.4380	3082711.0960	J-29S		Manual	T
679374.4420	3082791.3300	J-30S		Manual	T
679410.1490	3082845.8460	J-31S		Manual	T
679453.4760	3082914.1150	J-32S		Manual	T
679495.8840	3082940.9730	J-33S		Manual	T
679304.6530	3082548.6880	J-34S		Manual	T
679342.7410	3082605.3190	J-35S		Manual	T
679382.8900	3082667.5270	J-36S		Manual	T
679433.9450	3082731.6820	J-37S		Manual	T
679470.3570	3082776.7350	J-38S		Manual	T
679497.3310	3082840.3960	J-39S		Manual	T
679524.3310	3082886.8990	J-40S		Manual	T
679560.6070	3082897.2580	J-41S		Manual	T
679162.2041	3082722.8546		0	Adaptive-Fill	
679195.7534	3083012.6627		0	Adaptive-Fill	
679232.3198	3082923.1657		0	Adaptive-Fill	
679175.5100	3082877.7222		0	Adaptive-Fill	
679313.6644	3082781.3737		0	Adaptive-Fill	

679347.3587	3082877.9054		0	Adaptive-Fill	
679196.9579	3082789.6623		0	Adaptive-Fill	
679292.7628	3082895.8270		0	Adaptive-Fill	
679449.9501	3082977.9399		0	Adaptive-Fill	
679393.5333	3082904.4606		0	Adaptive-Fill	
679250.6679	3082557.0971		0	Adaptive-Fill	
679195.3275	3082960.3023		0	Adaptive-Fill	
679374.5614	3082738.4157		0	Adaptive-Fill	
679277.6086	3082735.1127		0	Adaptive-Fill	
679325.1430	3082653.9887		0	Adaptive-Fill	
679360.6484	3082550.4738		0	Adaptive-Fill	
679167.3155	3083360.0619		0	Adaptive-Fill	
679231.2642	3083067.5168		0	Adaptive-Fill	
679313.1883	3083041.4748		0	Adaptive-Fill	
679427.0046	3082677.1057		0	Adaptive-Fill	
679327.2245	3083290.7991		0	Adaptive-Fill	
679218.5890	3082747.8336		0	Adaptive-Fill	
679275.7863	3082604.1850		0	Adaptive-Fill	
679251.3585	3083274.2537		0	Adaptive-Fill	
679466.5193	3082869.1454		0	Adaptive-Fill	
679256.3743	3082868.6600		0	Adaptive-Fill	
679261.2163	3082699.1382		0	Adaptive-Fill	
679545.9291	3082854.0442		0	Adaptive-Fill	
679425.8016	3082940.6797		0	Adaptive-Fill	
679223.8148	3083180.9805		0	Adaptive-Fill	
679238.9868	3082967.3240		0	Adaptive-Fill	
679387.9482	3082596.8888		0	Adaptive-Fill	
679424.7998	3082881.3404		0	Adaptive-Fill	
679304.8247	3082998.1472		0	Adaptive-Fill	
679482.9969	3082738.7628		0	Adaptive-Fill	
679274.9752	3082811.1159		0	Adaptive-Fill	
679198.6419	3083315.3195		0	Adaptive-Fill	
679363.8999	3082836.9349		0	Adaptive-Fill	

Primary Sampling Objective
The primary purpose of sampling at this site is to compare a mean value of a site with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the mean value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the mean value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative hypothesis, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach
A parametric random sampling approach was used to determine the number of samples and to specify sampling locations. A parametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that parametric assumptions are reasonable. These assumptions will be examined in

post-sampling data analysis.

Both parametric and non-parametric approaches rely on assumptions about the population. However, non-parametric approaches typically require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than the number of samples required by non-parametric approaches.

Locating the sample points randomly provides data that are separated by many distances, whereas systematic samples are all equidistant apart. Therefore, random sampling provides more information about the spatial structure of the potential contamination than systematic sampling does. As with systematic sampling, random sampling also provides information regarding the mean value, but there is the possibility that areas of the site will not be represented with the same frequency as if uniform grid sampling were performed.

Number of Total Samples: Calculation Equation and Inputs
The equation used to calculate the number of samples is based on a Student's t-test. For this site, the null hypothesis is rejected in favor of the alternative hypothesis if the sample mean is sufficiently smaller than the threshold. The number of samples to collect is calculated so that 1) there will be a high probability ($1-\beta$) of rejecting the null hypothesis if the alternative hypothesis is true and 2) a low probability (α) of rejecting the null hypothesis if the null hypothesis is true.

The formula used to calculate the number of samples is:

$$n = \frac{S^2}{\Delta^2}\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2 + 0.5Z_{1-\alpha}^2$$

where
n is the number of samples,
S is the estimated standard deviation of the measured values including analytical error,
Δ is the width of the gray region,
α is the acceptable probability of incorrectly concluding the site mean is less than the threshold,
β is the acceptable probability of incorrectly concluding the site mean exceeds the threshold,
$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is $1-\alpha$,
$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is $1-\beta$.

The values of these inputs that result in the calculated number of sampling locations are:

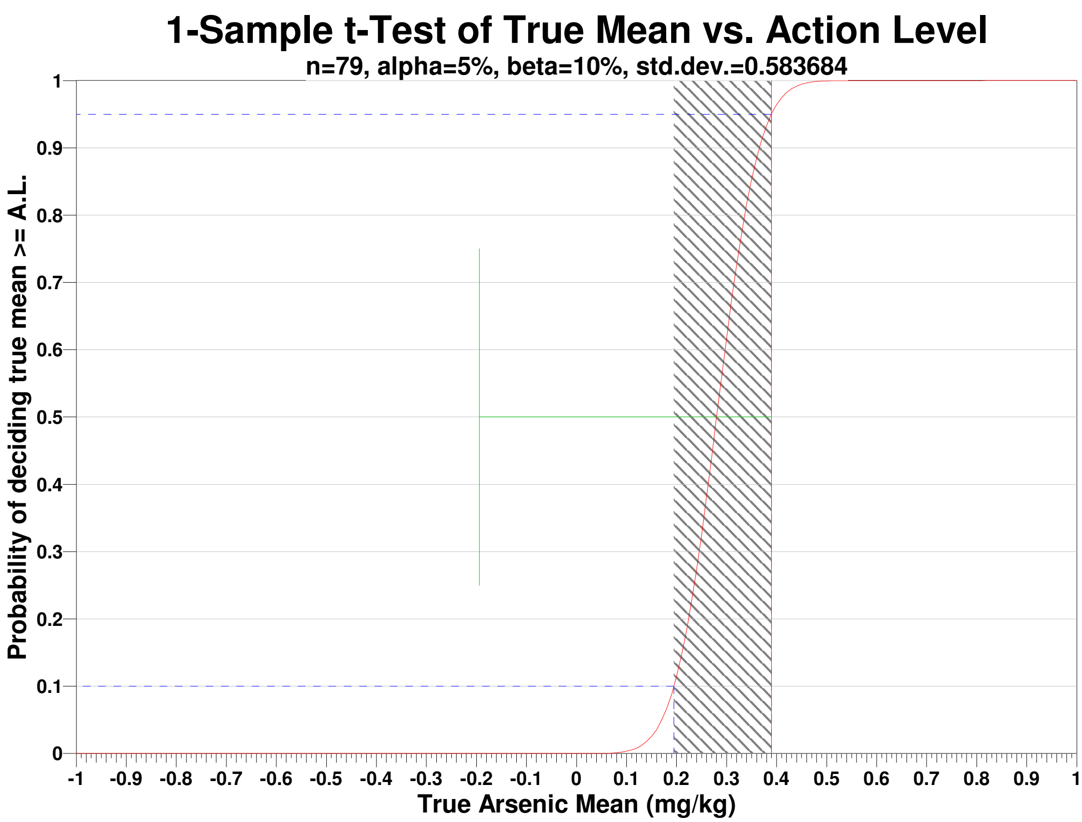
Analyte	n	Parameter					
		S	Δ	α	β	$Z_{1-\alpha}$ [a]	$Z_{1-\beta}$ [b]
New Location	2	0.1 mg/kg	10 mg/kg	0.05	0.1	1.64485	1.28155
1_2_4-Trimethylbenzene	2	0.0247235 mg/kg	26.0725 mg/kg	0.05	0.1	1.64485	1.28155
Acetone	2	0.0411995 mg/kg	2708.71 mg/kg	0.05	0.1	1.64485	1.28155
Aluminum	11	3361.66 mg/kg	3260.58 mg/kg	0.05	0.1	1.64485	1.28155
Arsenic	79	0.583684 mg/kg	0.194812 mg/kg	0.05	0.1	1.64485	1.28155
Barium	2	25.3192 mg/kg	3920.25 mg/kg	0.05	0.1	1.64485	1.28155
Beryllium	2	0.10236 mg/kg	18.7822 mg/kg	0.05	0.1	1.64485	1.28155
Carbon Disulfide	2	0.000685674 mg/kg	360.627 mg/kg	0.05	0.1	1.64485	1.28155
Chromium	2	2.69493 mg/kg	105.338 mg/kg	0.05	0.1	1.64485	1.28155
Chromium_ Hexavalent	2	0.24852 mg/kg	15.0482 mg/kg	0.05	0.1	1.64485	1.28155
Cobalt	2	0.499145 mg/kg	451.447 mg/kg	0.05	0.1	1.64485	1.28155
Copper	2	1.26381 mg/kg	273.798 mg/kg	0.05	0.1	1.64485	1.28155
Diethyl phthalate	2	0.0507891 mg/kg	712.182 mg/kg	0.05	0.1	1.64485	1.28155
Lead	2	3.95601 mg/kg	200 mg/kg	0.05	0.1	1.64485	1.28155
Manganese	2	53.722 mg/kg	1619.65 mg/kg	0.05	0.1	1.64485	1.28155

Mercury	2	0.0917868 mg/kg	1.04361 mg/kg	0.05	0.1	1.64485	1.28155
Methylene chloride	2	0.0159472 mg/kg	0.630571 mg/kg	0.05	0.1	1.64485	1.28155
Nickel	2	1.42019 mg/kg	416.052 mg/kg	0.05	0.1	1.64485	1.28155
Vanadium	2	3.39634 mg/kg	145.507 mg/kg	0.05	0.1	1.64485	1.28155
Xylene (total)	2	0.00342404 mg/kg	107.24 mg/kg	0.05	0.1	1.64485	1.28155
Zinc	2	5.98673 mg/kg	4960.74 mg/kg	0.05	0.1	1.64485	1.28155

[a] This value is automatically calculated by VSP based upon the user defined value of α.
[b] This value is automatically calculated by VSP based upon the user defined value of β.

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000) for Arsenic, the driving analyte. It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true mean values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at 1-α on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at 1-α. If any of the inputs change, the number of samples that result in the correct curve changes.



Statistical Assumptions
The assumptions associated with the formulas for computing the number of samples are:
1. the sample mean is normally distributed (this happens if the data are roughly symmetric or the sample size is more than 30; for extremely skewed data sets, additional samples may be required for the sample mean to be normally distributed),
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and

4. the sampling locations will be selected randomly.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the sample locations were selected using a random process.

Sensitivity Analysis

The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that μ > action level and alpha (%), probability of mistakenly concluding that μ < action level. The following table shows the results of this analysis.

Number of Samples							
AL=0.389624		α=5		α=10		α=15	
		s=1.16737	s=0.583684	s=1.16737	s=0.583684	s=1.16737	s=0.583684
LBGR=90	β=5	9717	2431	7689	1923	6455	1614
	β=10	7689	1924	5899	1476	4824	1207
	β=15	6456	1615	4825	1207	3858	965
LBGR=80	β=5	2431	609	1923	482	1614	404
	β=10	1924	482	1476	370	1207	302
	β=15	1615	405	1207	303	965	242
LBGR=70	β=5	1081	272	856	215	718	180
	β=10	856	215	657	165	537	135
	β=15	719	181	537	135	430	108

s = Standard Deviation
LBGR = Lower Bound of Gray Region (% of Action Level)
β = Beta (%), Probability of mistakenly concluding that μ > action level
α = Alpha (%), Probability of mistakenly concluding that μ < action level
AL = Action Level (Threshold)

Cost of Sampling

The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that are based on the number of samples collected and measured. Based on the numbers of samples determined above, the estimated total cost of sampling and analysis at this site is $40,500.00, which averages out to a per sample cost of $512.66. The following table summarizes the inputs and resulting cost estimates.

COST INFORMATION			
Cost Details	**Per Analysis**	**Per Sample**	**79 Samples**
Field collection costs		$100.00	$7,900.00
Analytical costs	$400.00	$400.00	$31,600.00
Sum of Field & Analytical costs		**$500.00**	**$39,500.00**
Fixed planning and validation costs			$1,000.00
Total cost			**$40,500.00**

Data Analysis for New Location

The following data points were entered by the user for analysis.

New Location (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0

20	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0		

SUMMARY STATISTICS for New Location	
n	38
Min	0
Max	0
Range	0
Mean	0
Median	0
Variance	0
StdDev	0
Std Error	0
Skewness	-1.#IND
Interquartile Range	0

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0	0	0	0	0	0	0	0	0

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for New Location			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	0	-1	Yes

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	1.061e+292
Shapiro-Wilk 5% Critical Value	1.376e-313

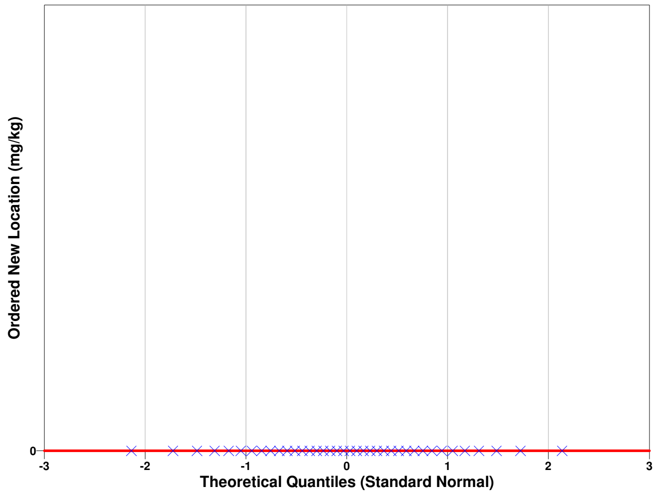
The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

Data Plots for New Location
Graphical displays of the data are shown below.

The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.



For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for New Location
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0
Shapiro-Wilk 5% Critical Value	0.938

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0
95% Non-Parametric (Chebyshev) UCL	0

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=38 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=37 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.#IND	1.6871	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
-1	-1	Reject

Data Analysis for 1_2_4-Trimethylbenzene
The following data points were entered by the user for analysis.

1_2_4-Trimethylbenzene (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00055	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006
10	0.0006	0.00065	0.00065	0.00065	0.00065	0.00065	0.00065	0.00065	0.00065	0.00065
20	0.00065	0.00065	0.00065	0.00065	0.00065	0.00065	0.00065	0.00065	0.0007	0.0007
30	0.0007	0.0007	0.0007	0.0007	0.0007	0.00075	0.0017	0.0022	0.0025	0.0796
40	0.14									

SUMMARY STATISTICS for 1_2_4-Trimethylbenzene								
n	41							
Min	0.00055							
Max	0.14							
Range	0.13945							
Mean	0.0060793							
Median	0.00065							
Variance	0.00061125							
StdDev	0.024723							
Std Error	0.0038612							
Skewness	4.8579							
Interquartile Range	0.0001							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00055	0.0006	0.0006	0.0006	0.00065	0.0007	0.0021	0.07189	0.14

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for 1_2_4-Trimethylbenzene			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.417	3.05	Yes

The test statistic 5.417 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for 1_2_4-Trimethylbenzene	
1	0.14

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.1749
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

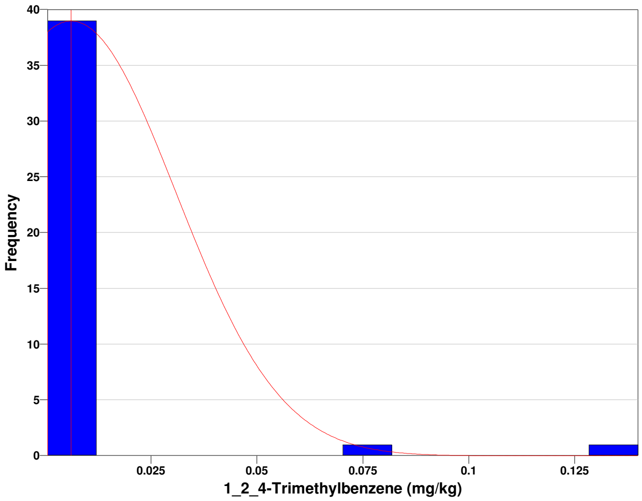
Data Plots for 1_2_4-Trimethylbenzene
Graphical displays of the data are shown below.

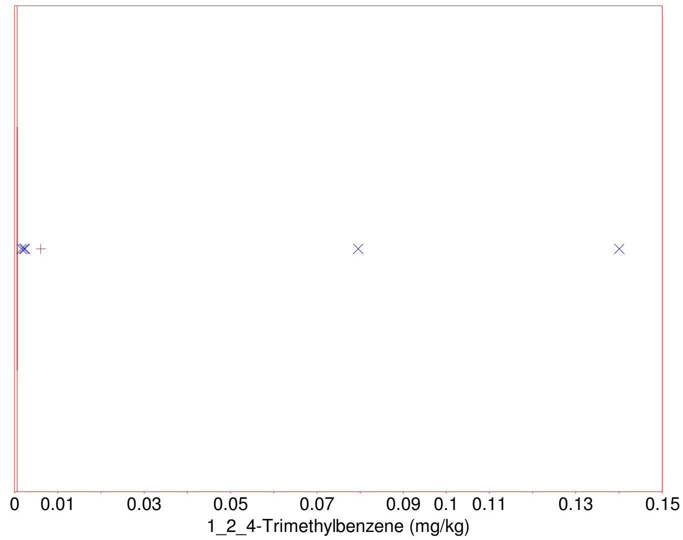
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

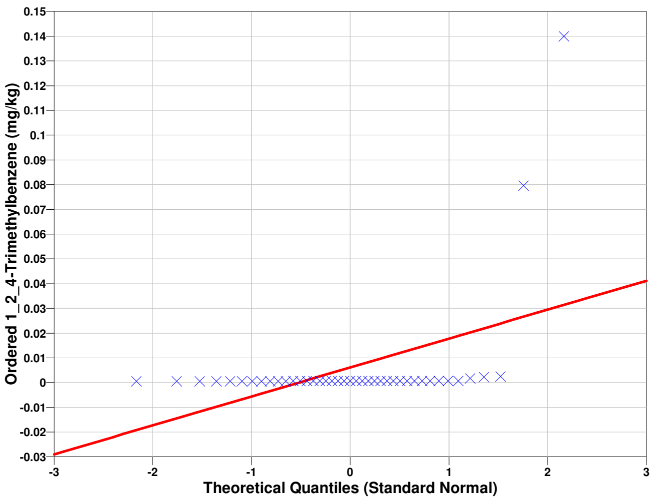
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the

Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for 1_2_4-Trimethylbenzene

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.2457
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.01258
95% Non-Parametric (Chebyshev) UCL	0.02291

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.02291) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-13503	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Acetone
The following data points were entered by the user for analysis.

Acetone (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0041	0.0041	0.0041	0.00415	0.0042	0.00425	0.00435	0.0044	0.0046	0.0046
10	0.0082	0.0092	0.01	0.0109	0.0112	0.0127	0.0127	0.0127	0.0155	0.0158
20	0.0163	0.0179	0.0199	0.0219	0.0228	0.0234	0.0259	0.0265	0.0268	0.027
30	0.0307	0.0324	0.0326	0.0337	0.034	0.035	0.047	0.0675	0.0697	0.109
40	0.249									

SUMMARY STATISTICS for Acetone	
n	41

Min				0.0041				
Max				0.249				
Range				0.2449				
Mean				0.027579				
Median				0.0163				
Variance				0.0016974				
StdDev				0.041199				
Std Error				0.0064342				
Skewness				4.2737				
Interquartile Range				0.02515				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0041	0.0041	0.00416	0.0064	0.0163	0.03155	0.0634	0.1051	0.249

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Acetone			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.374	3.05	Yes

The test statistic 5.374 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Acetone	
1	0.249

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7667
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

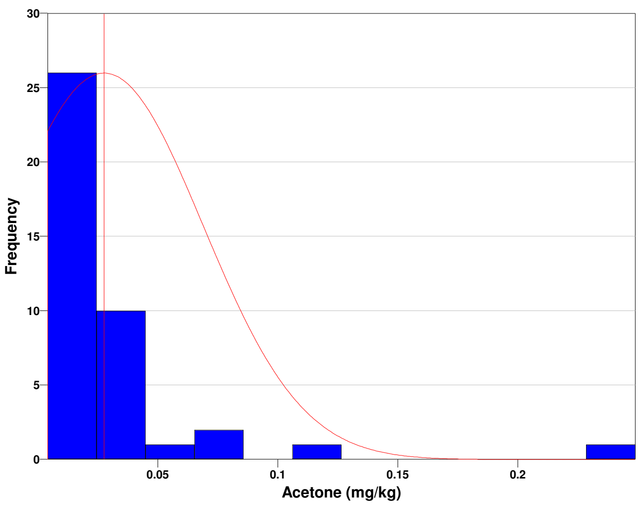
Data Plots for Acetone

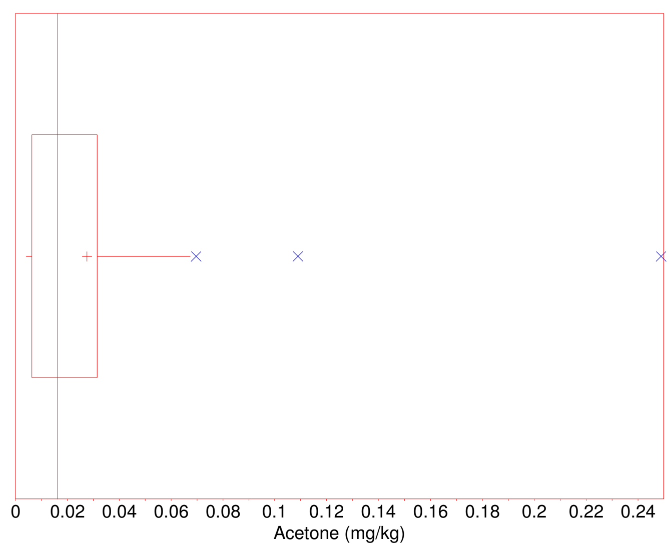
Graphical displays of the data are shown below.

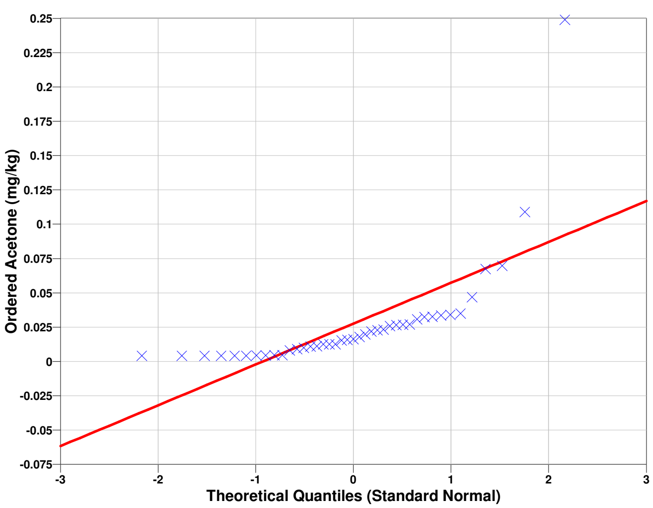
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Acetone
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5344
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.03841
95% Non-Parametric (Chebyshev) UCL	0.05563

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.05563) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-8.4196e+005	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**

41	26	Reject

Data Analysis for Aluminum
The following data points were entered by the user for analysis.

Aluminum (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	648	747	748	790	858	915	917	959	1090	1110
10	1130	1160	1200	1240	1390	1500	1760	1770	1830	1960
20	2140	2250	2460	2480	2800	3310	3510	3630	3640	4180
30	4660	5140	5880	6880	7640	7690	8450	9150	1.09e+004	1.14e+004
40	1.38e+004									

SUMMARY STATISTICS for Aluminum								
n	41							
Min	648							
Max	13800							
Range	13152							
Mean	3554							
Median	2140							
Variance	1.13e+007							
StdDev	3361.6							
Std Error	524.99							
Skewness	1.4859							
Interquartile Range	3780							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
648	747.1	803.6	1120	2140	4900	9010	1.135e+004	1.38e+004

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Aluminum			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.048	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8
Shapiro-Wilk 5% Critical Value	0.94

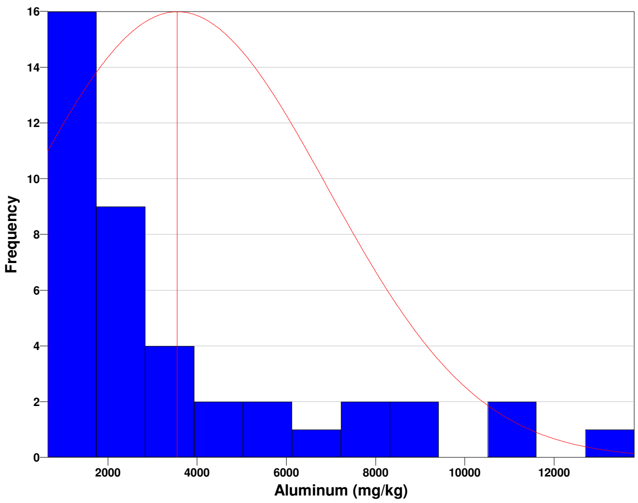
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

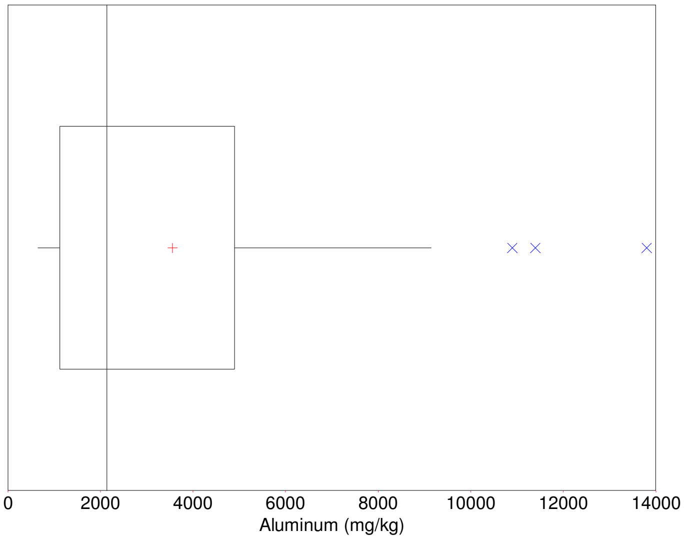
Data Plots for Aluminum
Graphical displays of the data are shown below.

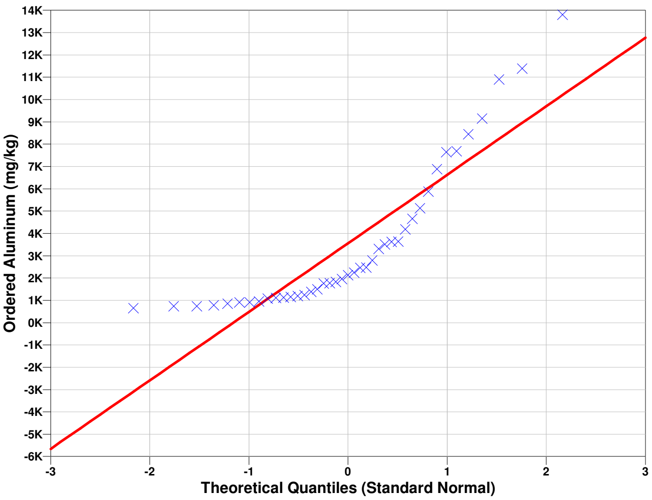
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Aluminum
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7943
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	4438

95% Non-Parametric (Chebyshev) UCL	5842

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (5842) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-5.6519	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
33	26	Reject

Data Analysis for Arsenic
The following data points were entered by the user for analysis.

Arsenic (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.08	0.09	0.1	0.1	0.105	0.105	0.11	0.115	0.115	0.12
10	0.14	0.23	0.23	0.26	0.29	0.3	0.33	0.34	0.38	0.41
20	0.44	0.47	0.54	0.54	0.58	0.62	0.7	0.74	0.78	0.8
30	0.81	1	1	1.1	1.2	1.4	1.7	1.7	1.7	2.1
40	2.2									

SUMMARY STATISTICS for Arsenic	
n	41
Min	0.08
Max	2.2

Range				2.12				
Mean				0.63585				
Median				0.44				
Variance				0.34069				
StdDev				0.58368				
Std Error				0.091156				
Skewness				1.2458				
Interquartile Range				0.775				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.08	0.091	0.101	0.13	0.44	0.905	1.7	2.06	2.2

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Arsenic			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.68	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8461
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

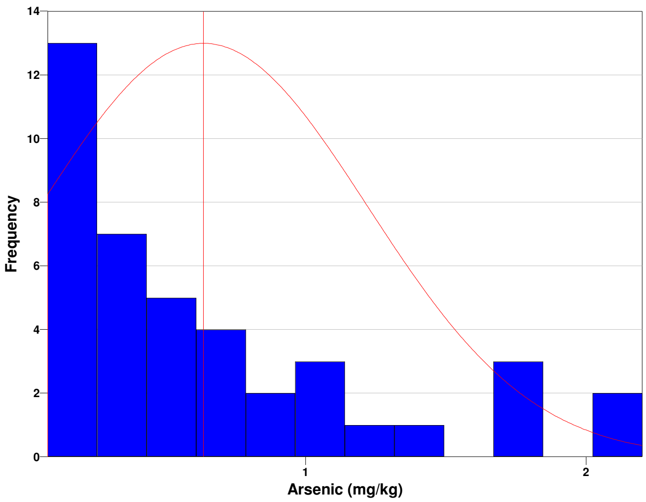
Data Plots for Arsenic
Graphical displays of the data are shown below.

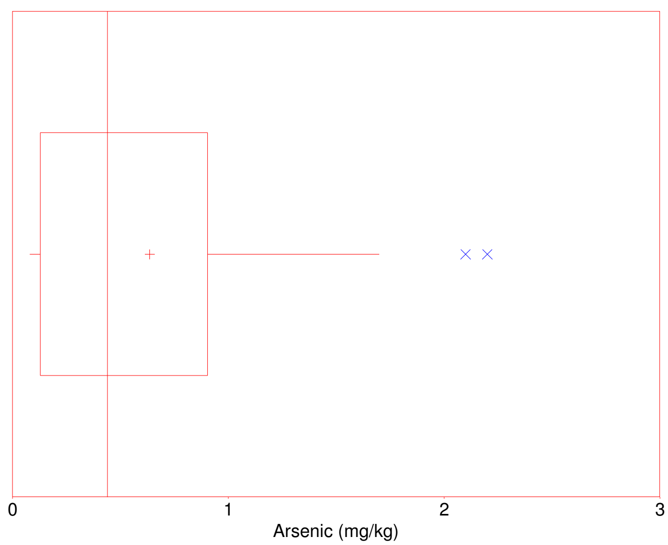
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally

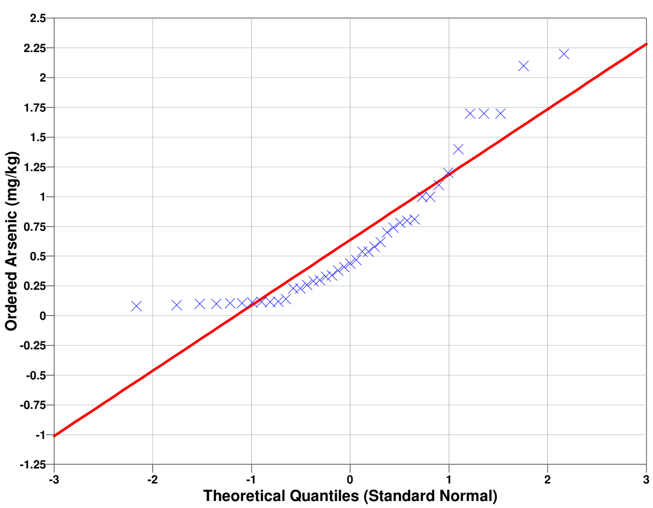
distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Arsenic

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was

conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8361
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.7893
95% Non-Parametric (Chebyshev) UCL	1.033

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (1.033) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
2.7012	1.6839	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
19	26	Cannot Reject
Note: There may not be enough data to reject the null hypothesis (and conclude site is clean) with 95% confidence using the MARSSIM sign test.		

Data Analysis for Barium
The following data points were entered by the user for analysis.

Barium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	4.2	4.6	5.4	6.7	7.4	7.7	8.5	8.6	9.6	10.2
10	11.4	11.5	11.8	12	12.4	13.5	16.3	21.5	23.1	23.5
20	25	25.1	25.2	26.4	26.5	29.3	31.1	36.2	39.1	39.6
30	41.8	47.2	47.5	50.6	52.4	59.7	66.9	77.7	78.7	97.8
40	98.7									

SUMMARY STATISTICS for Barium	
n	41
Min	4.2
Max	98.7
Range	94.5
Mean	30.546
Median	25
Variance	641.13
StdDev	25.321
Std Error	3.9544
Skewness	1.2462
Interquartile Range	33.7

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
4.2	4.68	6.84	10.8	25	44.5	75.54	95.89	98.7

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Barium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.692	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is

recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8687
Shapiro-Wilk 5% Critical Value	0.94

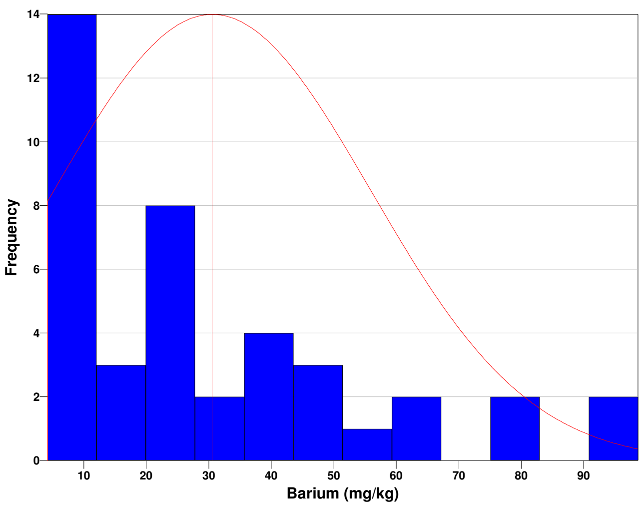
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

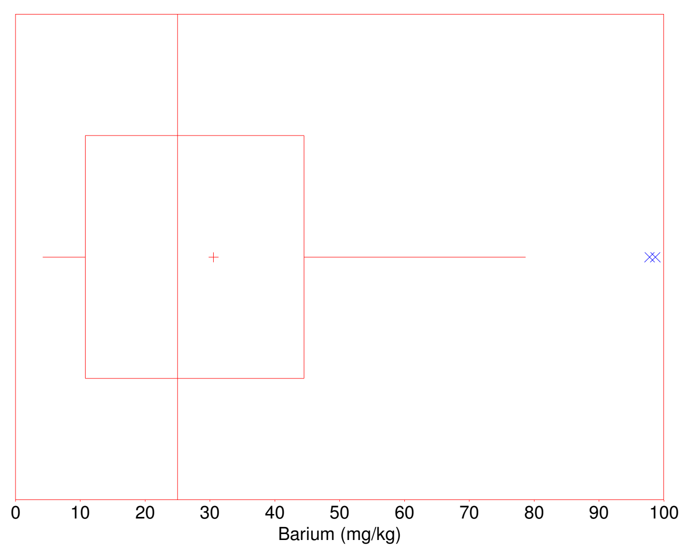
Data Plots for Barium
Graphical displays of the data are shown below.

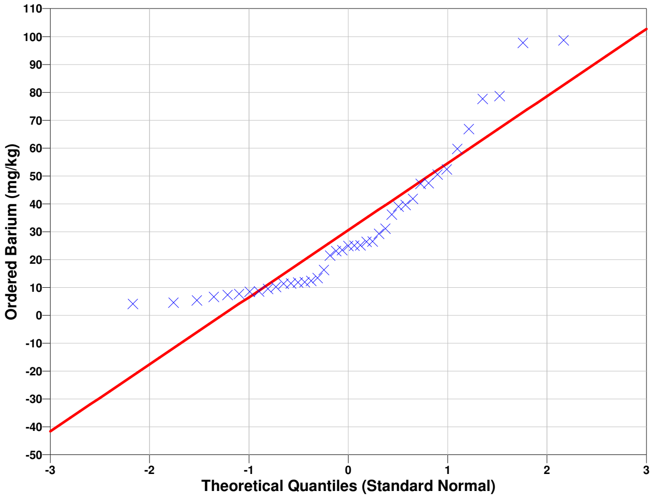
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Barium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8521
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	37.2
95% Non-Parametric (Chebyshev) UCL	47.78

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (47.78) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1975	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Beryllium
The following data points were entered by the user for analysis.

Beryllium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.009	0.0115	0.0115	0.012	0.013	0.014	0.023	0.023	0.035	0.035
10	0.041	0.042	0.044	0.0445	0.047	0.054	0.064	0.064	0.067	0.086
20	0.097	0.1	0.1	0.1	0.11	0.11	0.11	0.12	0.13	0.13
30	0.15	0.15	0.19	0.21	0.25	0.27	0.28	0.29	0.3	0.32
40	0.42									

SUMMARY STATISTICS for Beryllium	
n	41
Min	0.009
Max	0.42
Range	0.411
Mean	0.11409
Median	0.097
Variance	0.010478
StdDev	0.10236
Std Error	0.015986
Skewness	1.2312
Interquartile Range	0.112

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.009	0.0115	0.0122	0.038	0.097	0.15	0.288	0.318	0.42

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Beryllium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.989	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8565
Shapiro-Wilk 5% Critical Value	0.94

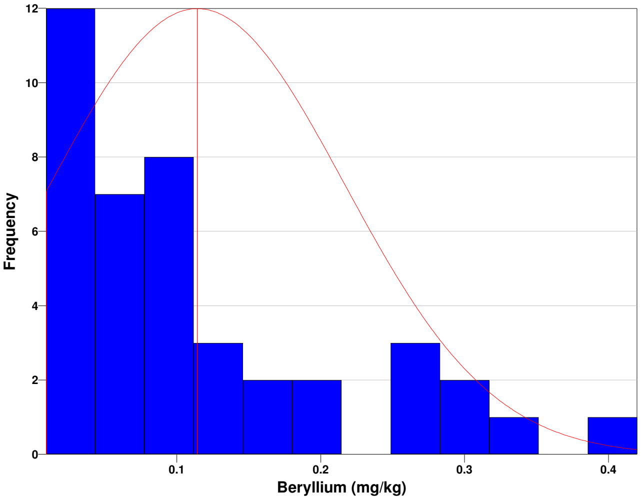
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

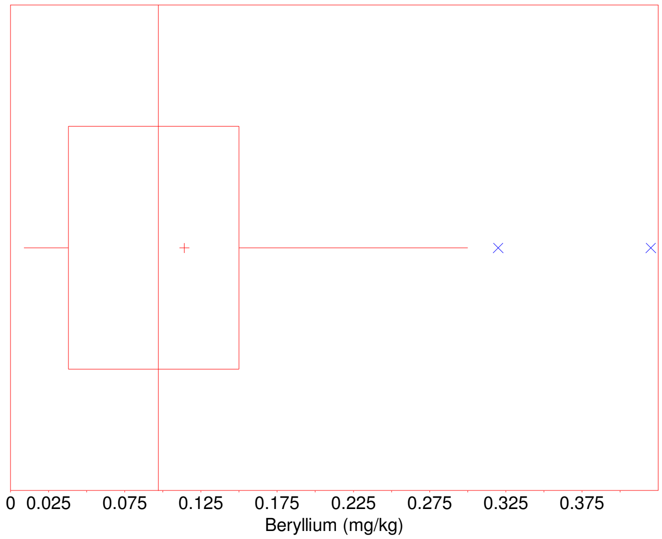
Data Plots for Beryllium
Graphical displays of the data are shown below.

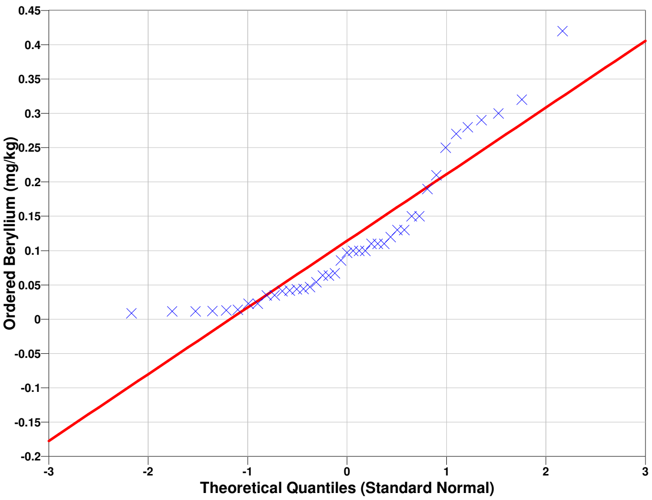
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Beryllium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8553
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.141

95% Non-Parametric (Chebyshev) UCL	0.1838

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.1838) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-2342.7	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Carbon Disulfide
The following data points were entered by the user for analysis.

Carbon Disulfide (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00065	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007
10	0.0007	0.0007	0.0007	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075
20	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.0008
30	0.0008	0.0008	0.0008	0.00085	0.00155	0.0016	0.002	0.0021	0.0023	0.0025
40	0.0041									

SUMMARY STATISTICS for Carbon Disulfide	
n	41
Min	0.00065
Max	0.0041

Range	0.00345
Mean	0.0010061
Median	0.00075
Variance	4.7015e-007
StdDev	0.00068567
Std Error	0.00010708
Skewness	3.0231
Interquartile Range	0.0001

Percentiles

1%	5%	10%	25%	50%	75%	90%	95%	99%
0.00065	0.0007	0.0007	0.0007	0.00075	0.0008	0.00208	0.00248	0.0041

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Carbon Disulfide			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.512	3.05	Yes

The test statistic 4.512 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Carbon Disulfide	
1	0.0041

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5218
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

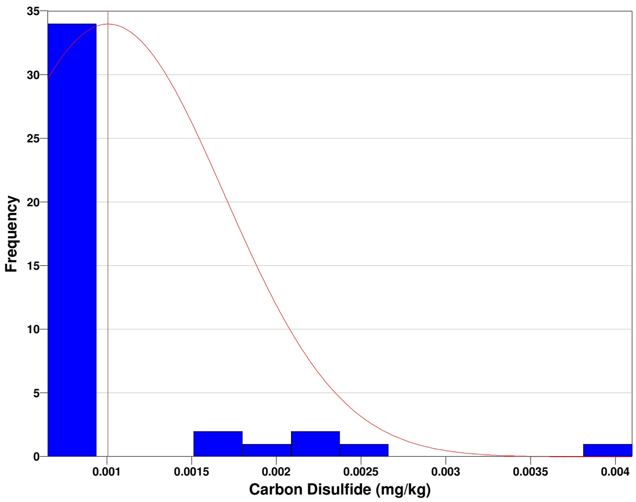
Data Plots for Carbon Disulfide
Graphical displays of the data are shown below.

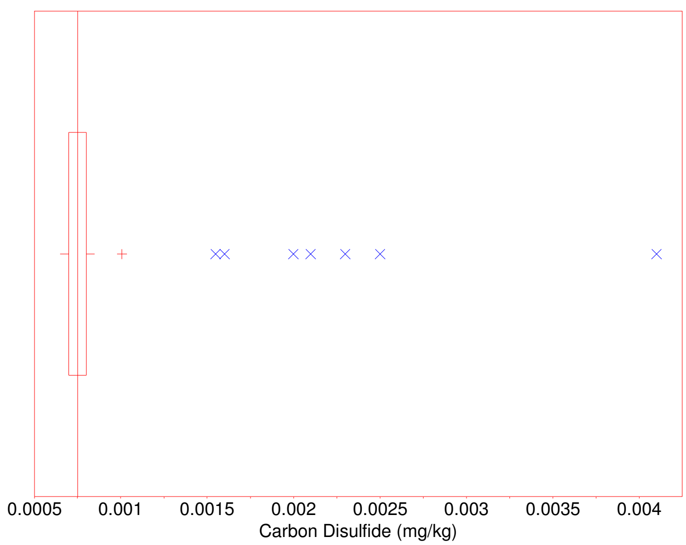
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

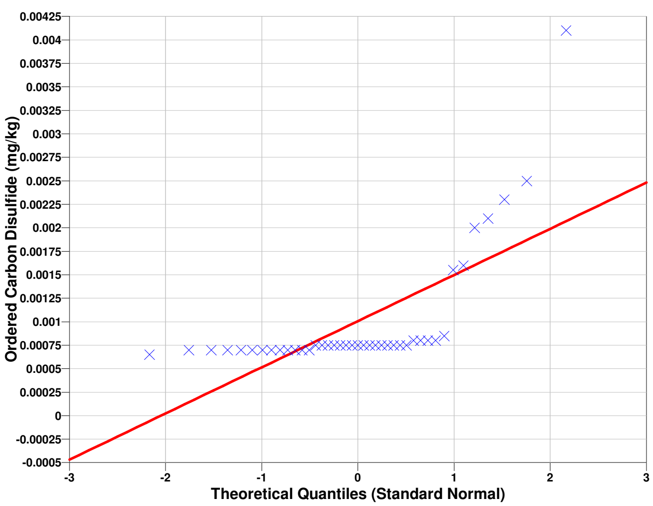
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Carbon Disulfide
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5151
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.001186
95% Non-Parametric (Chebyshev) UCL	0.001473

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.001473) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-6.7354e+006	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Chromium
The following data points were entered by the user for analysis.

Chromium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.58	0.59	0.6	0.63	0.76	0.8	0.98	1	1.2	1.2
10	1.4	1.5	1.7	1.8	1.8	1.9	2.1	2.2	2.2	2.3
20	2.4	2.5	2.5	2.7	2.9	3.2	3.2	3.4	3.5	3.7
30	3.7	3.9	4.1	4.3	4.9	5.2	6	6.1	7.4	8.8
40	15									

SUMMARY STATISTICS for Chromium								
n	41							
Min	0.58							
Max	15							
Range	14.42							
Mean	3.0888							
Median	2.4							
Variance	7.2627							
StdDev	2.6949							
Std Error	0.42088							
Skewness	2.5355							
Interquartile Range	2.5							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.58	0.591	0.656	1.3	2.4	3.8	6.08	8.66	15

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Chromium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.42	3.05	Yes

The test statistic 4.42 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Chromium

1	15

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8953
Shapiro-Wilk 5% Critical Value	0.94

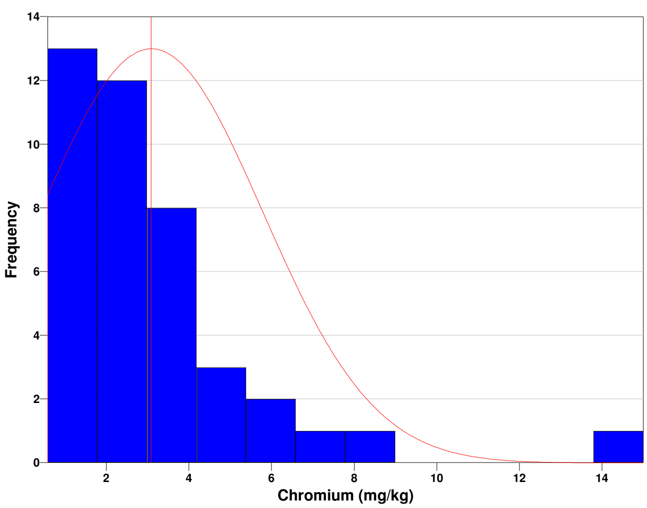
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

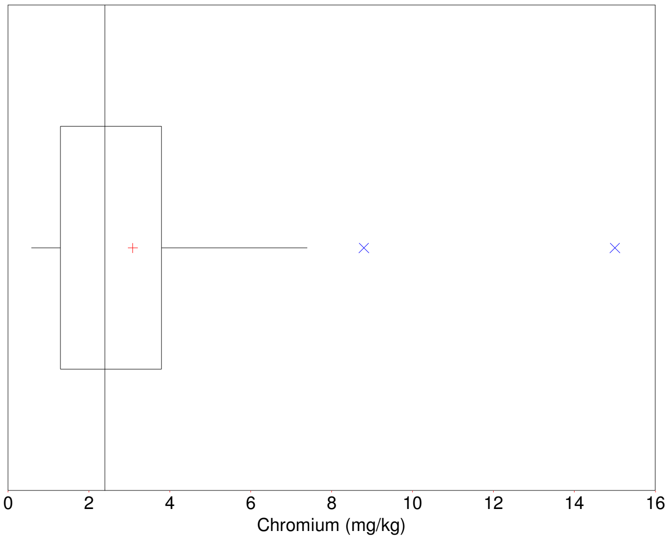
Data Plots for Chromium
Graphical displays of the data are shown below.

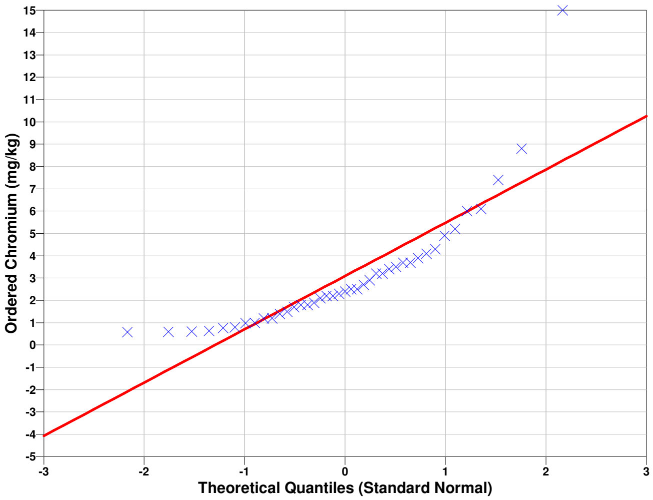
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Chromium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7725
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	3.797

95% Non-Parametric (Chebyshev) UCL	4.923

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (4.923) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-493.22	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Chromium_ Hexavalent
The following data points were entered by the user for analysis.

Chromium_ Hexavalent (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.55	0.55
10	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
20	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.65	0.65	0.65
30	0.65	0.65	0.65	0.65	0.7	0.7	1.1	1.2	1.3	1.3
40	1.6									

SUMMARY STATISTICS for Chromium_ Hexavalent	
n	41
Min	0.5
Max	1.6

Range	1.1
Mean	0.67683
Median	0.6
Variance	0.061762
StdDev	0.24852
Std Error	0.038812
Skewness	2.4548
Interquartile Range	0.075

Percentiles

1%	5%	10%	25%	50%	75%	90%	95%	99%
0.5	0.5	0.5	0.575	0.6	0.65	1.18	1.3	1.6

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Chromium_ Hexavalent			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.715	3.05	Yes

The test statistic 3.715 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Chromium_ Hexavalent	
1	1.6

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6004
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

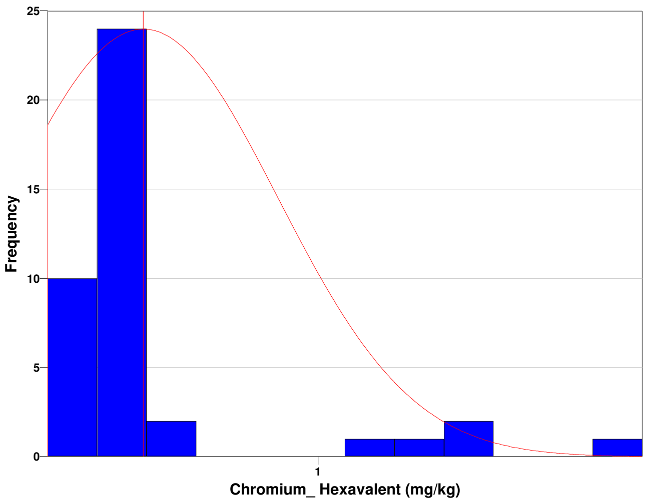
Data Plots for Chromium_ Hexavalent
Graphical displays of the data are shown below.

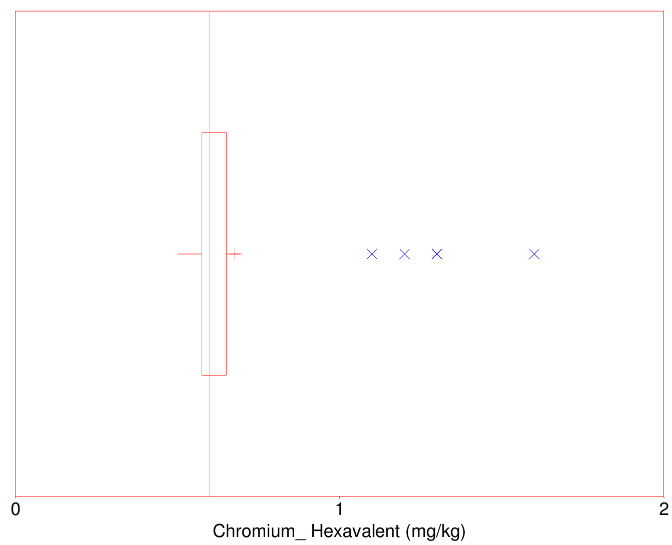
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

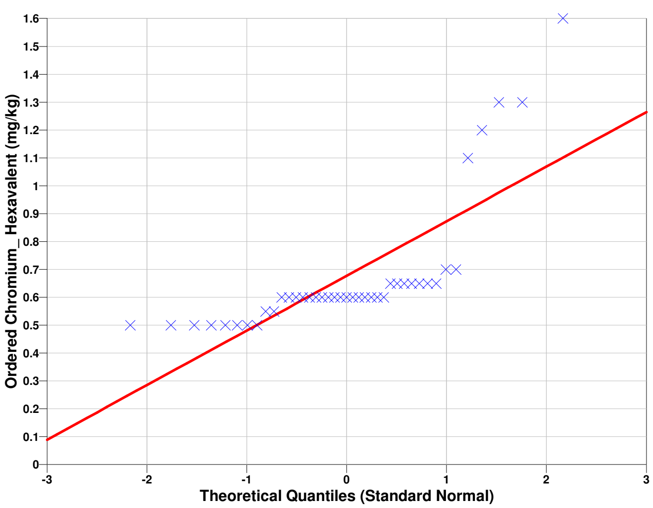
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Chromium_ Hexavalent
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6066
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.7422
95% Non-Parametric (Chebyshev) UCL	0.846

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.846) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-758	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Cobalt
The following data points were entered by the user for analysis.

Cobalt (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.07	0.08	0.09	0.09	0.095	0.095	0.095	0.1	0.1	0.105
10	0.11	0.125	0.24	0.25	0.26	0.31	0.34	0.35	0.39	0.44
20	0.48	0.5	0.55	0.56	0.56	0.58	0.58	0.61	0.69	0.715
30	0.72	0.73	0.78	0.84	0.99	1.1	1.2	1.5	1.7	1.9
40	1.9									

SUMMARY STATISTICS for Cobalt								
n	41							
Min	0.07							
Max	1.9							
Range	1.83							
Mean	0.55902							
Median	0.48							
Variance	0.24915							
StdDev	0.49914							
Std Error	0.077953							
Skewness	1.3458							
Interquartile Range	0.6175							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.07	0.081	0.091	0.1075	0.48	0.725	1.44	1.88	1.9

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Cobalt			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.687	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the

suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8517
Shapiro-Wilk 5% Critical Value	0.94

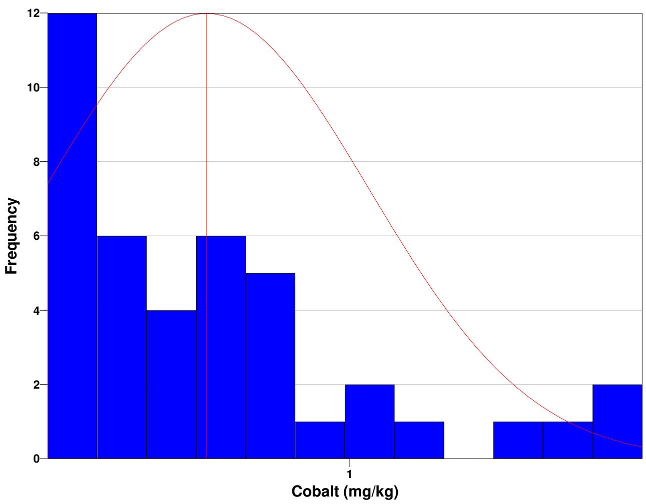
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

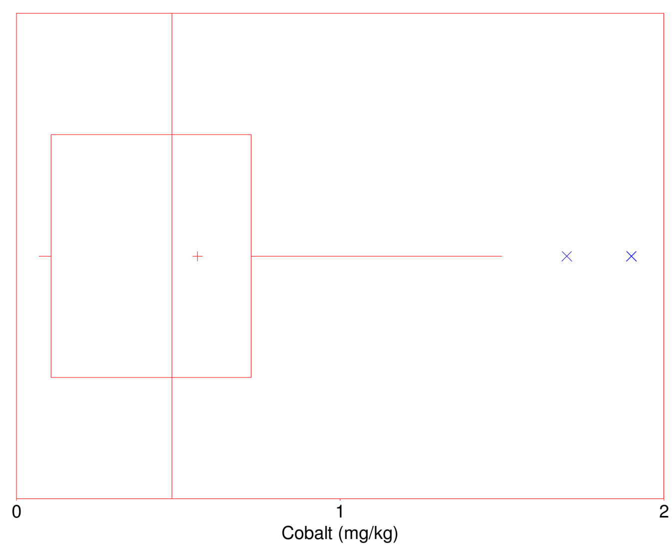
Data Plots for Cobalt
Graphical displays of the data are shown below.

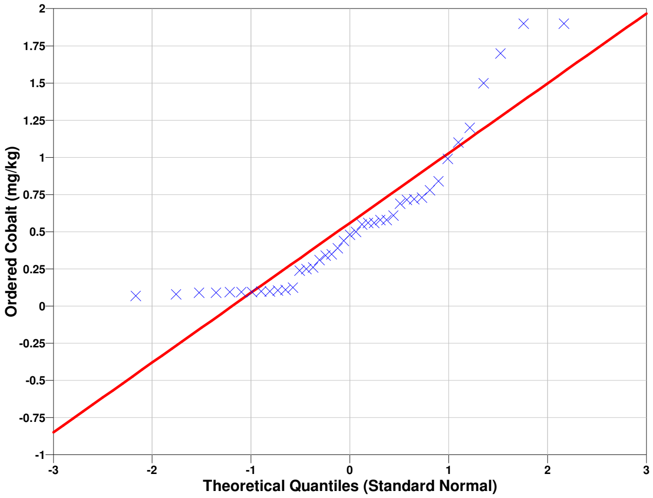
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Cobalt
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.835
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.6903
95% Non-Parametric (Chebyshev) UCL	0.8988

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.8988) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-11575	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Copper
The following data points were entered by the user for analysis.

Copper (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.35	0.39	0.39	0.44	0.45	0.47	0.48	0.49	0.58	0.59
10	0.61	0.62	0.72	0.725	0.79	0.89	0.9	0.92	0.96	1
20	1.1	1.1	1.2	1.2	1.3	1.3	1.5	1.6	1.7	1.8
30	1.9	1.9	1.9	2	2.1	2.4	3.8	3.9	4.1	4.4
40	5.9									

SUMMARY STATISTICS for Copper								
n	41							
Min	0.35							
Max	5.9							
Range	5.55							
Mean	1.4845							
Median	1.1							
Variance	1.5972							
StdDev	1.2638							
Std Error	0.19737							
Skewness	1.8525							
Interquartile Range	1.3							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.35	0.39	0.442	0.6	1.1	1.9	3.88	4.37	5.9

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Copper			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.494	3.05	Yes

The test statistic 3.494 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Copper	
1	5.9

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8002
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

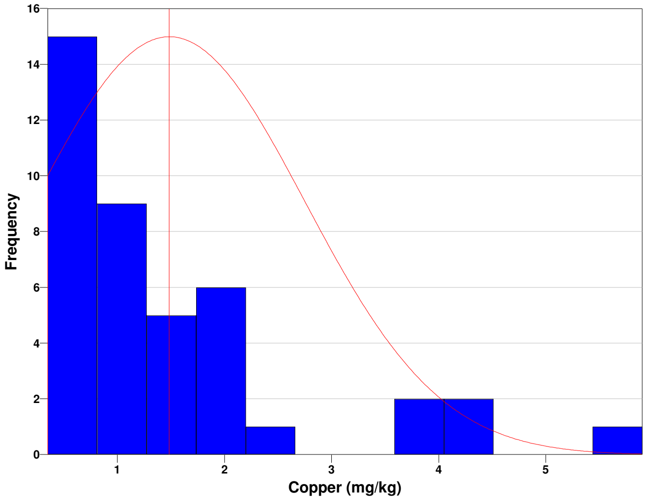
Data Plots for Copper
Graphical displays of the data are shown below.

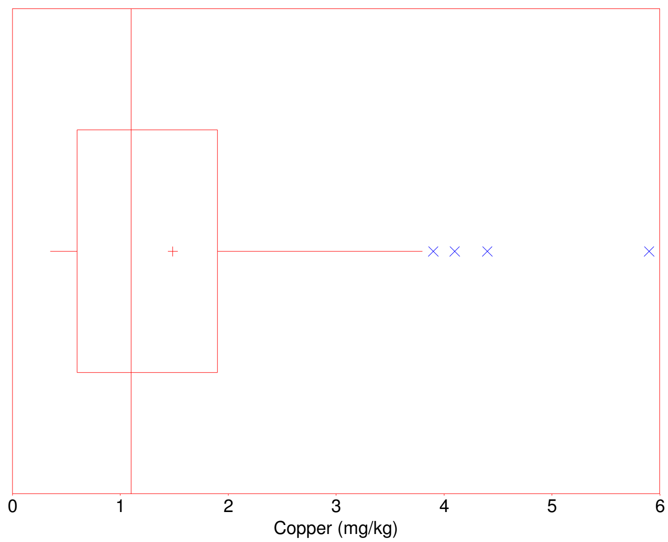
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

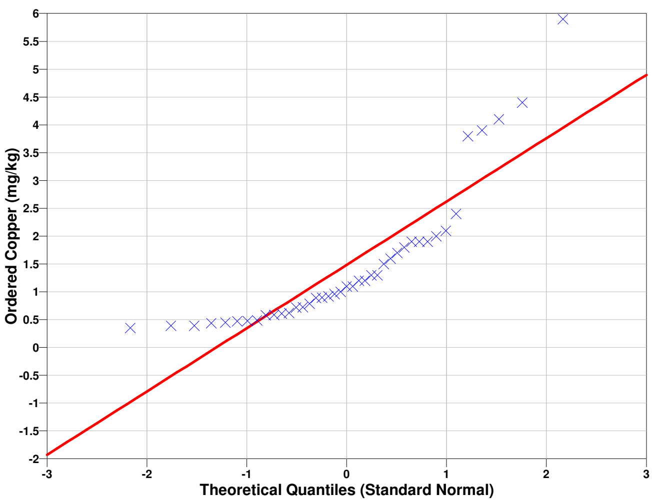
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the

Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Copper

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7798
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	1.817
95% Non-Parametric (Chebyshev) UCL	2.345

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (2.345) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-2766.9	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Diethyl phthalate
The following data points were entered by the user for analysis.

Diethyl phthalate (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.024	0.026	0.026	0.026	0.0265	0.0265	0.0265	0.0265	0.027	0.027
10	0.027	0.027	0.027	0.027	0.027	0.027	0.0275	0.0275	0.0275	0.0275
20	0.0275	0.0275	0.028	0.0285	0.0285	0.0285	0.0285	0.029	0.029	0.0295
30	0.0295	0.0305	0.031	0.0315	0.0763	0.0952	0.101	0.111	0.12	0.123
40	0.31									

SUMMARY STATISTICS for Diethyl phthalate	
n	41

Min	0.024
Max	0.31
Range	0.286
Mean	0.045793
Median	0.0275
Variance	0.0025795
StdDev	0.050789
Std Error	0.0079319
Skewness	3.952
Interquartile Range	0.003

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.024	0.026	0.0261	0.027	0.0275	0.03	0.109	0.1227	0.31

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Diethyl phthalate			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.202	3.05	Yes

The test statistic 5.202 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Diethyl phthalate	
1	0.31

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.4949
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

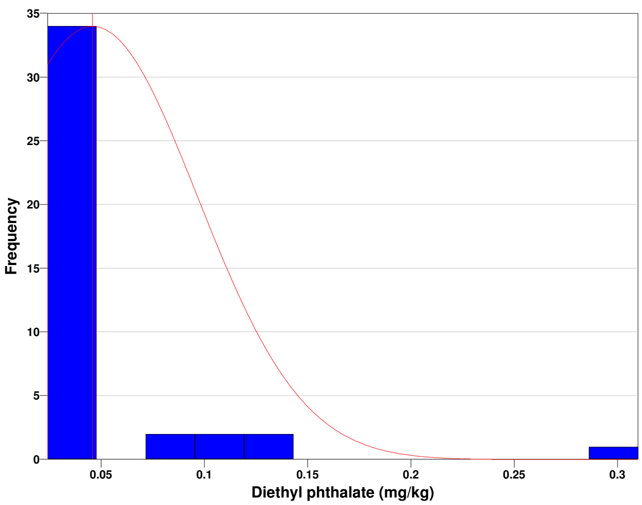
Data Plots for Diethyl phthalate

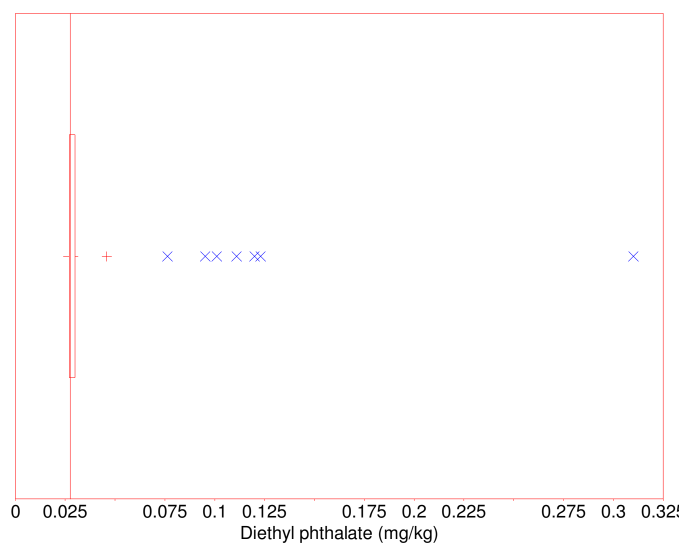
Graphical displays of the data are shown below.

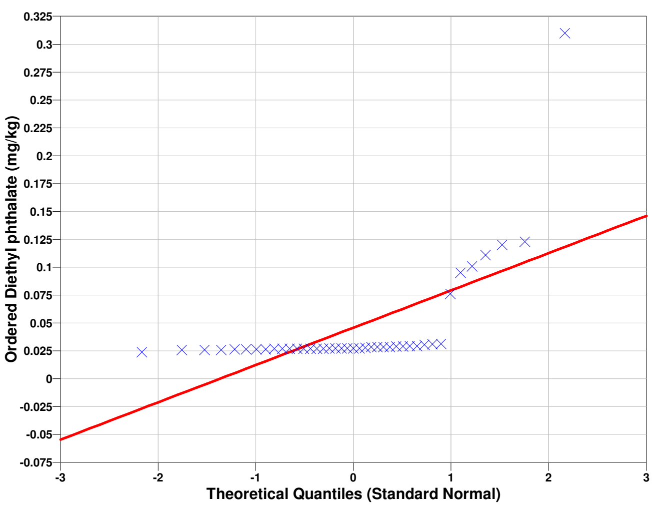
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Diethyl phthalate
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.4472
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.05915
95% Non-Parametric (Chebyshev) UCL	0.08037

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.08037) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x	is the sample mean of the n=41 data,
AL	is the action level or threshold (0.389624),
SE	is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.7957e+005	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**

41	26	Reject

Data Analysis for Lead
The following data points were entered by the user for analysis.

Lead (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1.3	1.5	1.5	1.6	1.7	1.7	1.8	1.9	1.9	1.9
10	2	2.1	2.15	2.3	2.3	2.3	2.3	2.4	2.5	2.6
20	2.7	2.7	2.7	2.8	3.1	3.2	3.2	3.5	3.6	3.8
30	4.1	4.2	4.2	4.3	5.7	5.9	6	6.3	6.8	9.3
40	26									

SUMMARY STATISTICS for Lead								
n	41							
Min	1.3							
Max	26							
Range	24.7							
Mean	3.7524							
Median	2.7							
Variance	15.65							
StdDev	3.956							
Std Error	0.61782							
Skewness	4.7237							
Interquartile Range	2.2							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
1.3	1.5	1.62	1.95	2.7	4.15	6.24	9.05	26

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Lead			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.624	3.05	Yes

The test statistic 5.624 exceeded the corresponding critical value, therefore that test is significant and we conclude that the

most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Lead	
1	26

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.835
Shapiro-Wilk 5% Critical Value	0.94

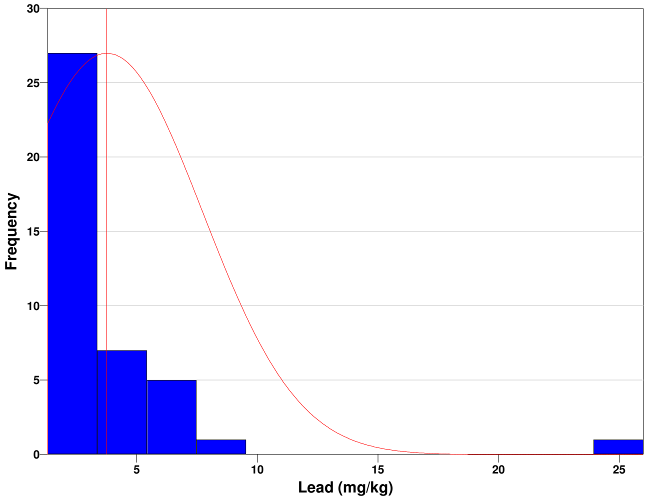
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

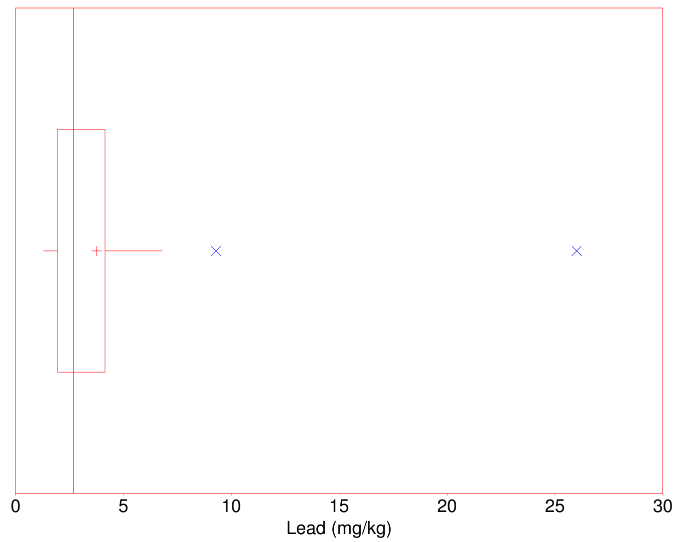
Data Plots for Lead
Graphical displays of the data are shown below.

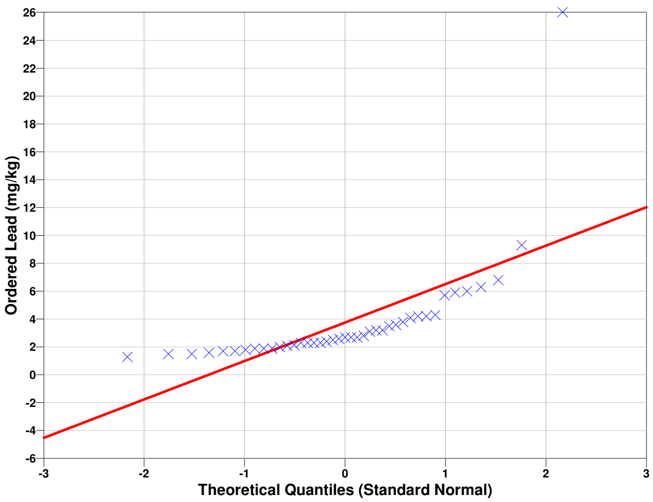
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Lead
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5047
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	4.793

95% Non-Parametric (Chebyshev) UCL	6.445

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (6.445) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-641.36	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Manganese
The following data points were entered by the user for analysis.

Manganese (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	2.7	3.1	3.5	4.1	4.4	4.5	4.6	5.1	5.5	6.2
10	7.5	9	9.1	9.9	9.9	10.1	10.8	11.9	12.9	13.9
20	17.2	17.8	19.7	21.3	29	31.7	36	49.3	51.3	54.3
30	69.5	70.1	73	75	76.3	112	130	134	146	153
40	241									

SUMMARY STATISTICS for Manganese	
n	41
Min	2.7
Max	241

Range				238.3				
Mean				42.834				
Median				17.2				
Variance				2886.1				
StdDev				53.723				
Std Error				8.3901				
Skewness				1.8878				
Interquartile Range				62.95				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
2.7	3.14	4.16	6.85	17.2	69.8	133.2	152.3	241

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Manganese			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.689	3.05	Yes

The test statistic 3.689 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Manganese	
1	241

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7607
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

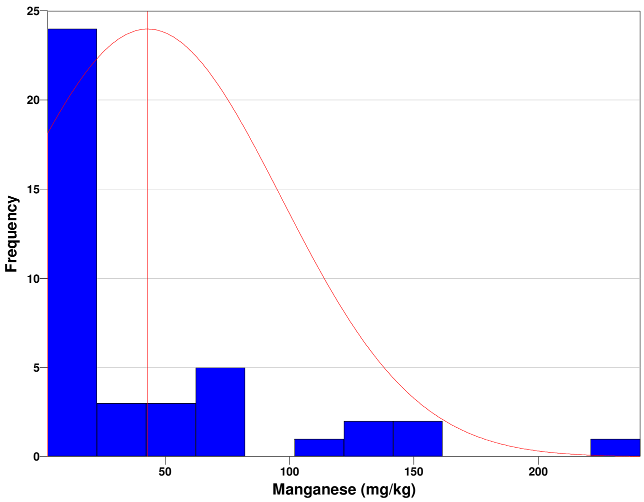
Data Plots for Manganese
Graphical displays of the data are shown below.

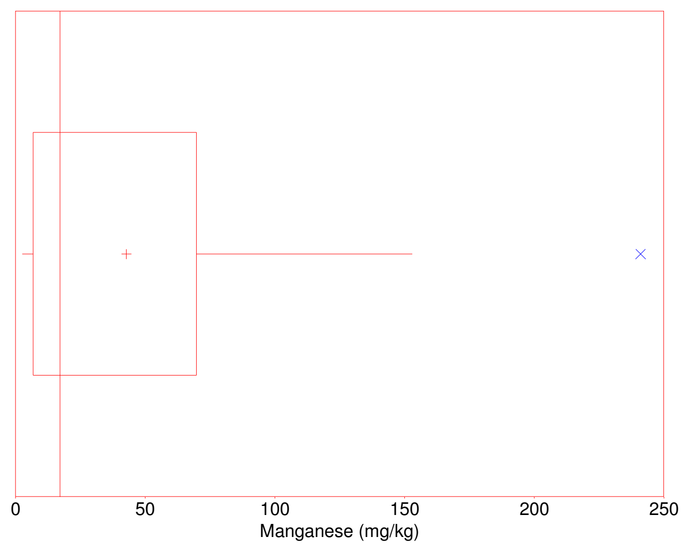
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

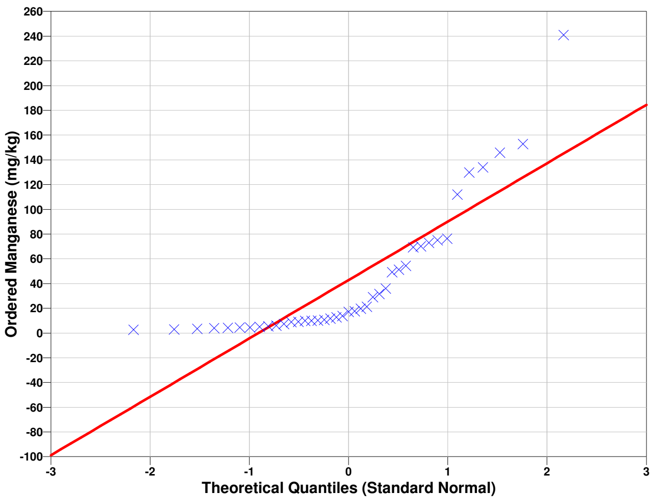
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Manganese
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7451
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	56.96
95% Non-Parametric (Chebyshev) UCL	79.41

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (79.41) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-380.98	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Mercury
The following data points were entered by the user for analysis.

Mercury (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00035	0.00036	0.000365	0.00038	0.00038	0.00038	0.000385	0.00043	0.00044	0.0013
10	0.0017	0.0021	0.0024	0.0025	0.0026	0.0038	0.0043	0.0045	0.0046	0.0048
20	0.0048	0.0051	0.0053	0.0065	0.0072	0.0073	0.0077	0.008	0.01	0.011
30	0.012	0.012	0.013	0.014	0.019	0.033	0.048	0.054	0.055	0.055
40	0.59									

SUMMARY STATISTICS for Mercury								
n	41							
Min	0.00035							
Max	0.59							
Range	0.58965							
Mean	0.02478							
Median	0.0048							
Variance	0.0084248							
StdDev	0.091787							
Std Error	0.014335							
Skewness	6.13							
Interquartile Range	0.0105							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00035	0.0003605	0.00038	0.0015	0.0048	0.012	0.0528	0.055	0.59

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Mercury			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	6.158	3.05	Yes

The test statistic 6.158 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Mercury

1	0.59

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6364
Shapiro-Wilk 5% Critical Value	0.94

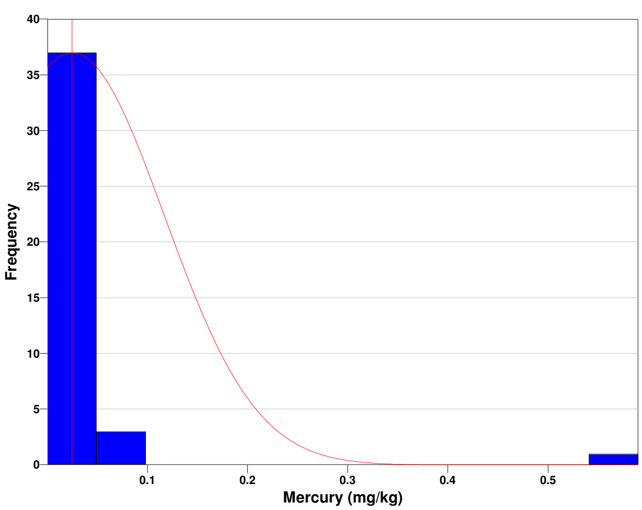
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

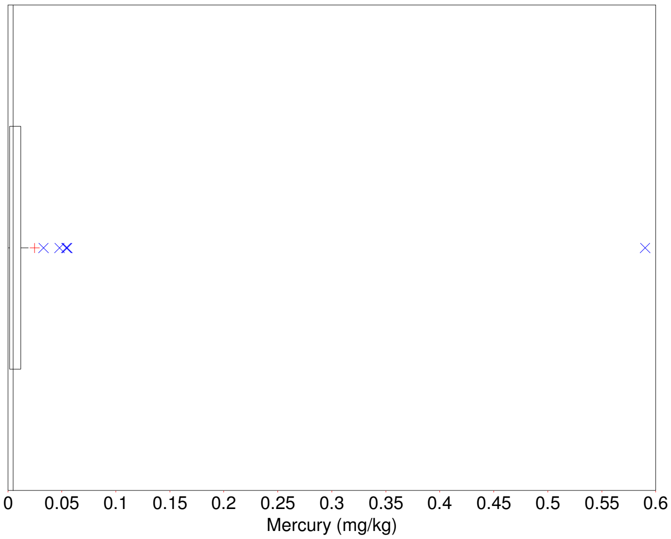
Data Plots for Mercury
Graphical displays of the data are shown below.

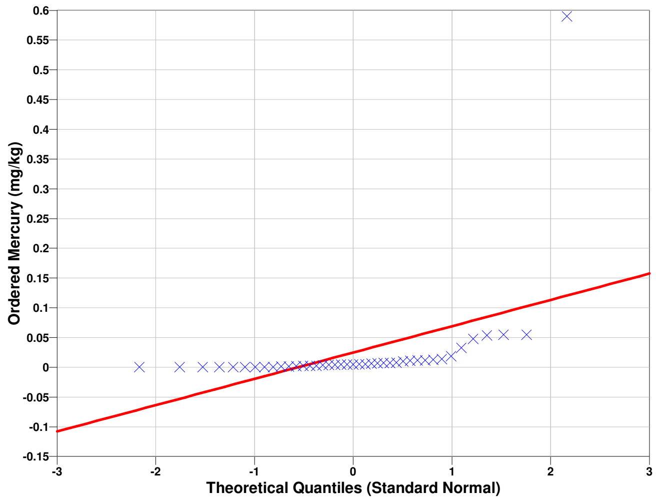
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Mercury
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.2612
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.04892

95% Non-Parametric (Chebyshev) UCL	0.08726

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.08726) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-143.88	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Methylene chloride
The following data points were entered by the user for analysis.

Methylene chloride (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00135	0.00135	0.00135	0.00135	0.00135	0.0014	0.0014	0.0014	0.00145	0.00145
10	0.00145	0.00145	0.00145	0.00145	0.00145	0.0015	0.0015	0.003	0.0031	0.0031
20	0.0034	0.0034	0.0039	0.0042	0.0044	0.0044	0.0048	0.0049	0.0053	0.0058
30	0.006	0.0072	0.0076	0.0078	0.0078	0.0101	0.0143	0.0146	0.016	0.0334
40	0.0999									

SUMMARY STATISTICS for Methylene chloride	
n	41
Min	0.00135
Max	0.0999

Range				0.09855				
Mean				0.007378				
Median				0.0034				
Variance				0.00025431				
StdDev				0.015947				
Std Error				0.0024905				
Skewness				5.2288				
Interquartile Range				0.00515				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00135	0.00135	0.00135	0.00145	0.0034	0.0066	0.01454	0.03166	0.0999

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Methylene chloride			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.802	3.05	Yes

The test statistic 5.802 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Methylene chloride	
1	0.0999

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6434
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

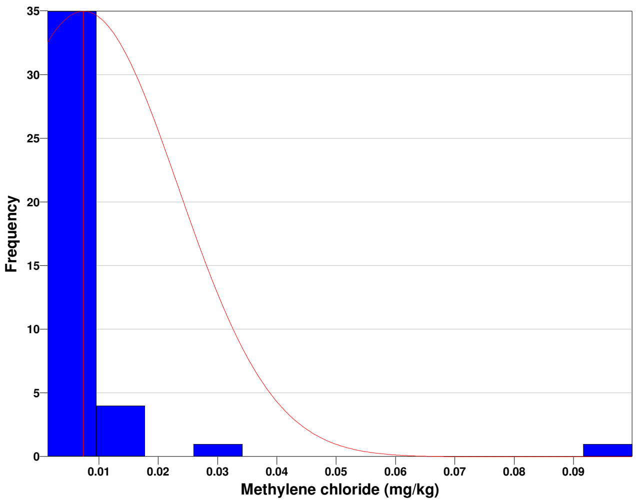
Data Plots for Methylene chloride
Graphical displays of the data are shown below.

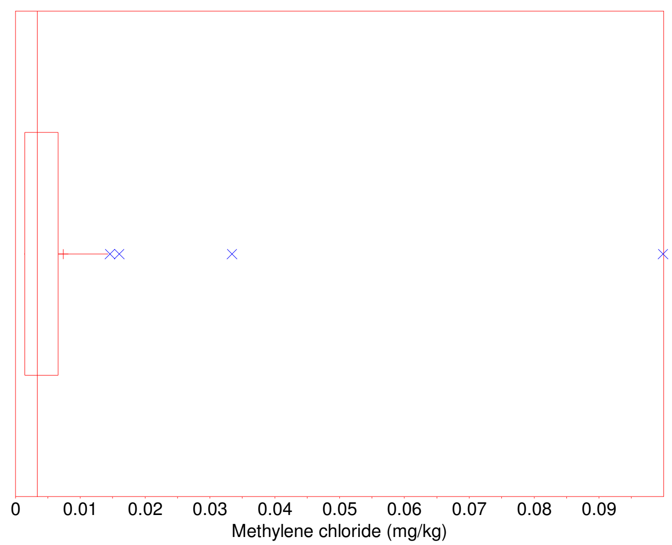
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

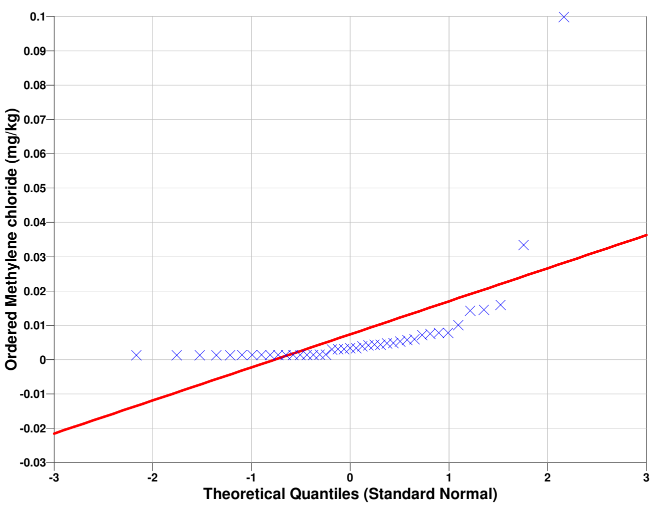
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Methylene chloride
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.3879
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.01157
95% Non-Parametric (Chebyshev) UCL	0.01823

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.01823) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-503.41	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Nickel
The following data points were entered by the user for analysis.

Nickel (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.06	0.065	0.08	0.18	0.21	0.22	0.22	0.23	0.26	0.26
10	0.28	0.29	0.32	0.36	0.36	0.39	0.46	0.66	0.73	0.99
20	1	1.1	1.3	1.3	1.4	1.4	1.4	1.5	1.5	1.8
30	1.8	1.8	1.8	1.8	2.4	2.6	2.9	3.6	4	5.8
40	5.9									

SUMMARY STATISTICS for Nickel	
n	41
Min	0.06
Max	5.9
Range	5.84
Mean	1.3348
Median	1
Variance	2.0169
StdDev	1.4202
Std Error	0.2218
Skewness	1.8288
Interquartile Range	1.53

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.06	0.0665	0.186	0.27	1	1.8	3.46	5.62	5.9

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Nickel			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.215	3.05	Yes

The test statistic 3.215 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Nickel

1	5.9

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8158
Shapiro-Wilk 5% Critical Value	0.94

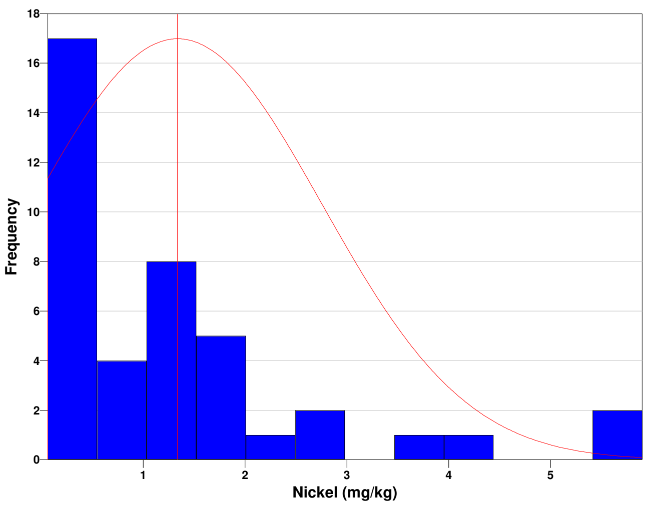
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

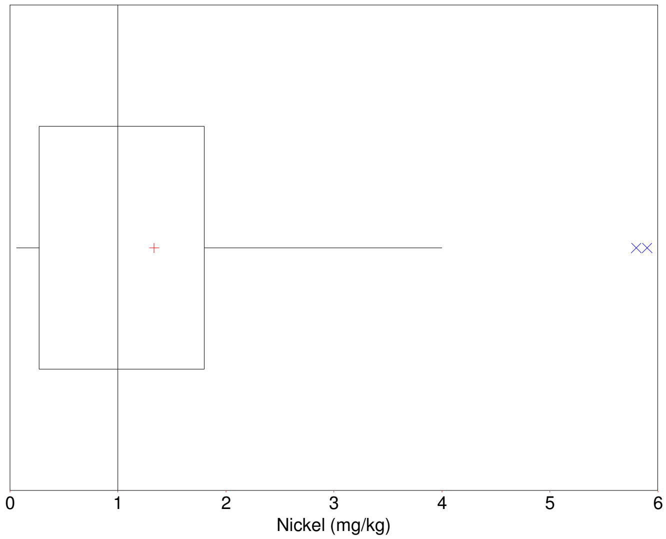
Data Plots for Nickel
Graphical displays of the data are shown below.

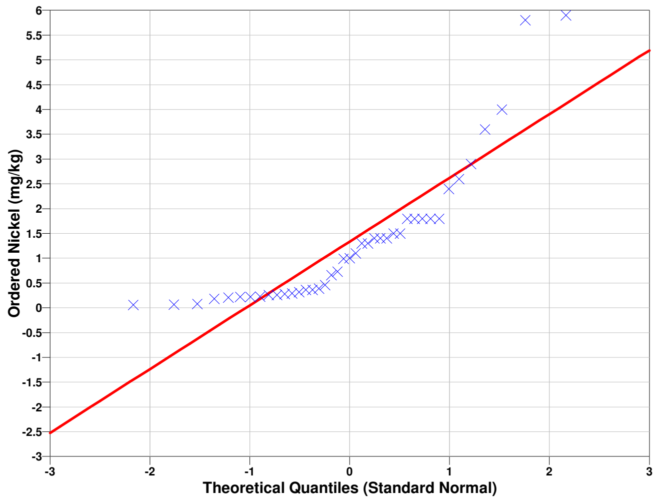
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Nickel
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.784
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	1.708

95% Non-Parametric (Chebyshev) UCL	2.302

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (2.302) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-3745.6	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Vanadium
The following data points were entered by the user for analysis.

Vanadium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.65	0.77	0.83	0.89	0.95	0.97	1	1.1	1.2	1.3
10	1.7	1.7	1.8	1.95	2	2.1	2.3	2.4	2.4	2.4
20	2.9	3.1	3.2	3.6	3.7	3.8	4.3	4.4	4.5	5
30	5.3	5.7	5.8	6	6.7	6.9	7.1	11	12.1	13
40	13.7									

SUMMARY STATISTICS for Vanadium	
n	41
Min	0.65
Max	13.7

Range				13.05				
Mean				3.9563				
Median				2.9				
Variance				11.535				
StdDev				3.3963				
Std Error				0.53042				
Skewness				1.5509				
Interquartile Range				4				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.65	0.776	0.902	1.5	2.9	5.5	10.22	12.91	13.7

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Vanadium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.869	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8286
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

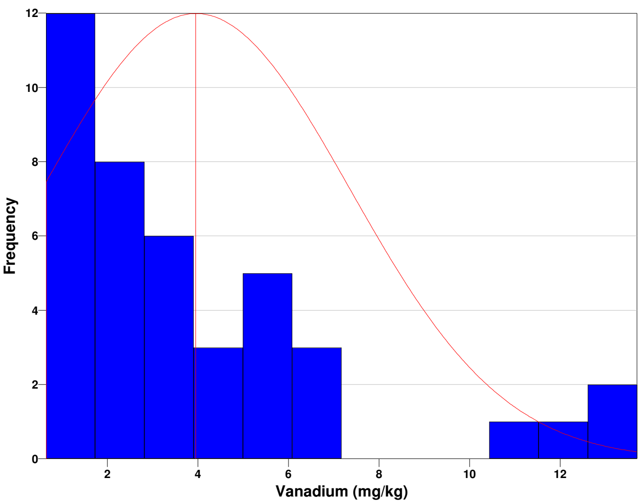
Data Plots for Vanadium
Graphical displays of the data are shown below.

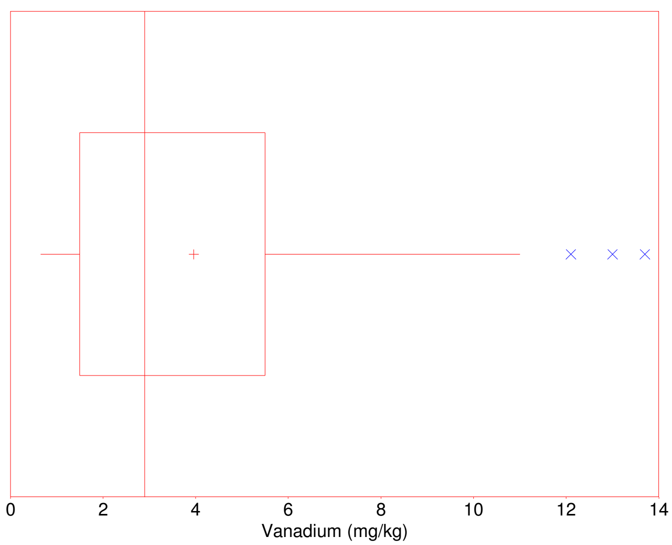
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally

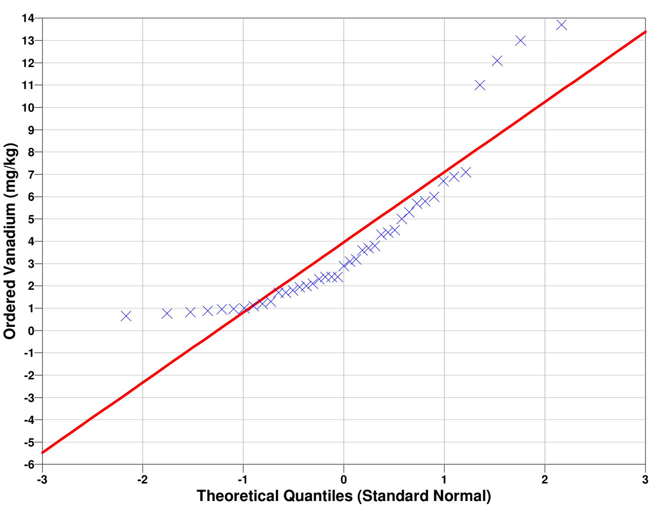
distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Vanadium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was

conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8131
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	4.849
95% Non-Parametric (Chebyshev) UCL	6.268

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (6.268) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-541.19	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Xylene (total)
The following data points were entered by the user for analysis.

Xylene (total) (mg/kg)

Rank	1	2	3	4	5	6	7	8	9	10
0	0.00195	0.00205	0.00205	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021
10	0.0021	0.00215	0.00215	0.00215	0.00215	0.0022	0.0022	0.0022	0.0022	0.0022
20	0.0022	0.0022	0.0022	0.0022	0.00223	0.00225	0.00225	0.0023	0.0023	0.0023
30	0.0023	0.00235	0.0024	0.0024	0.0024	0.00255	0.0045	0.0049	0.0064	0.0119
40	0.0217									

SUMMARY STATISTICS for Xylene (total)								
n	41							
Min	0.00195							
Max	0.0217							
Range	0.01975							
Mean	0.0031385							
Median	0.0022							
Variance	1.1724e-005							
StdDev	0.003424							
Std Error	0.00053474							
Skewness	4.6349							
Interquartile Range	0.000225							
Percentiles								
1%	5%	10%	25%	50%	75%	90%	95%	99%
0.00195	0.00205	0.0021	0.0021	0.0022	0.002325	0.00482	0.01135	0.0217

Outlier Test

Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Xylene (total)			
k	Test Statistic R_k	5% Critical Value C_k	Significant?
1	5.421	3.05	Yes

The test statistic 5.421 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Xylene (total)	
1	0.0217

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the

suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.3814
Shapiro-Wilk 5% Critical Value	0.94

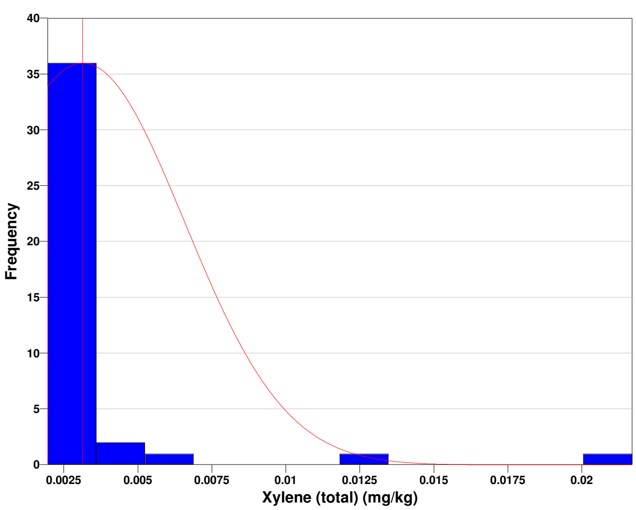
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

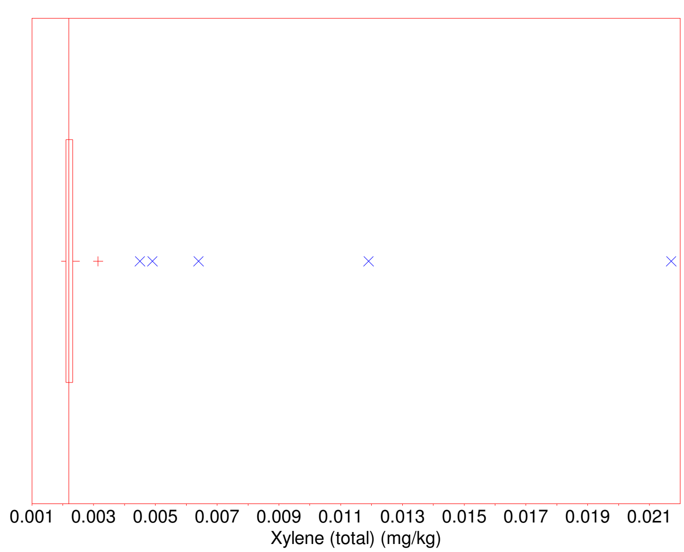
Data Plots for Xylene (total)
Graphical displays of the data are shown below.

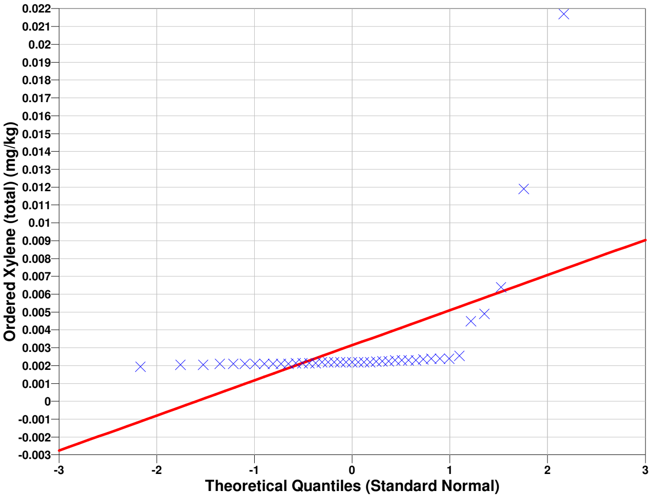
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Xylene (total)
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.3502
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.004039
95% Non-Parametric (Chebyshev) UCL	0.005469

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.005469) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-4.0109e+005	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Zinc
The following data points were entered by the user for analysis.

Zinc (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1.5	1.5	1.6	1.6	2.1	2.2	2.3	2.3	2.8	2.8
10	2.9	3.1	3.1	3.2	3.6	4.4	4.4	5.4	5.7	6.4
20	6.5	6.7	7	7	7.1	7.2	7.3	7.3	7.4	8.1
30	8.3	10.3	10.3	11	11	15	16.6	18.9	19.5	23.6
40	24.8									

SUMMARY STATISTICS for Zinc								
n	41							
Min	1.5							
Max	24.8							
Range	23.3							
Mean	7.4098							
Median	6.5							
Variance	35.841							
StdDev	5.9867							
Std Error	0.93497							
Skewness	1.486							
Interquartile Range	6.45							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
1.5	1.51	1.7	2.85	6.5	9.3	18.44	23.19	24.8

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Zinc			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.905	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8409
Shapiro-Wilk 5% Critical Value	0.94

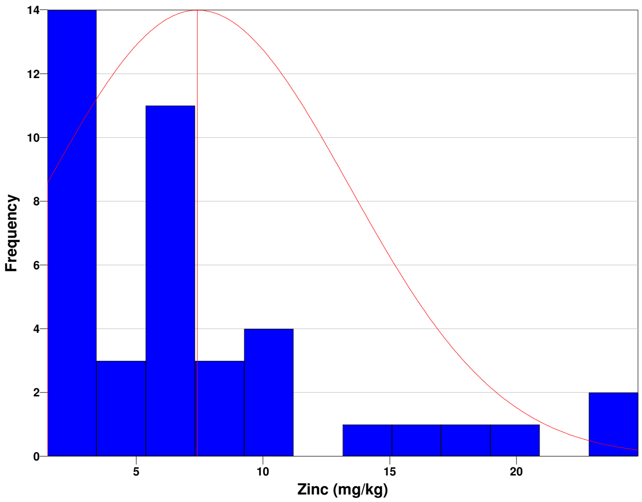
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

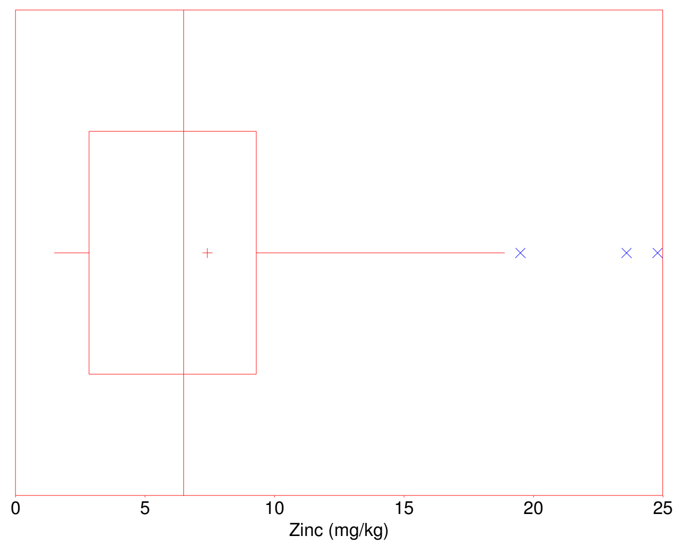
Data Plots for Zinc
Graphical displays of the data are shown below.

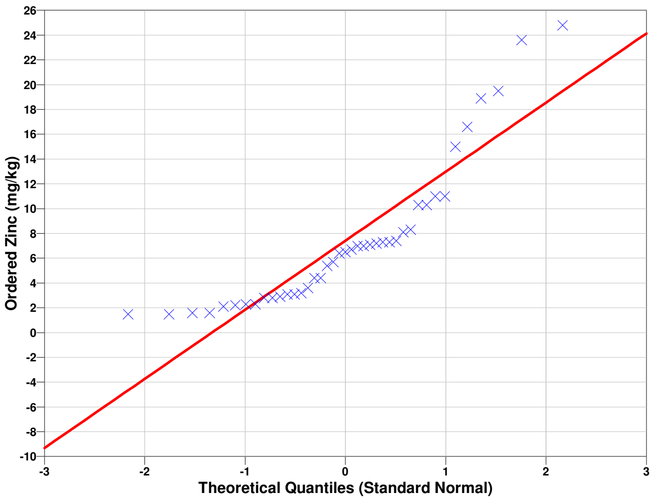
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Zinc

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.823
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	8.984

95% Non-Parametric (Chebyshev) UCL	11.49

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (11.49) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-10604	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

This report was automatically produced* by Visual Sample Plan (VSP) software version 5.3.1.
Software and documentation available at http://dqo.pnl.gov/vsp

* - The report contents may have been modified or reformatted by end-user of software.

Appendix C

VSP Reports of Calculated Minimum Sample Quantity
Report 7
Area of Concern – 1
Minimum Sample Quantity Calculation for Subsurface Soil using Ecological Benchmarks and Delta Method 1

Random sampling locations for comparing a mean with a fixed threshold (parametric)

Summary

This report summarizes the sampling design, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design for Vanadium, the driving analyte (the analyte which required the largest number of samples). A figure that shows sampling locations in the field and a table that lists sampling location coordinates are also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean to a fixed threshold
Type of Sampling Design	Parametric
Sample Placement (Location) in the Field	Simple random sampling
Working (Null) Hypothesis	The mean value at the site exceeds the threshold
Formula for calculating number of sampling locations	Student's t-test
Calculated total number of samples	28
Number of samples on map [a]	41
Number of selected sample areas [b]	1
Specified sampling area [c]	188054.34 m^2
Total cost of sampling [d]	$15,000.00

[a] This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[d] Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.

Area: Area 3					
X Coord	**Y Coord**	**Label**	**Value**	**Type**	**Historical**
679149.4920	3082933.0980	J-13S		Manual	T
679279.6830	3083075.4290	J-14S		Manual	T
679261.0980	3083016.3510	J-15S		Manual	T
679222.6340	3082840.1720	J-16S		Manual	T
679293.5600	3082950.4980	J-17S		Manual	T

679360.5700	3083026.4980	J-18S		Manual	T
679343.5810	3082969.5980	J-19S		Manual	T
679382.8640	3083009.1130	J-20S		Manual	T
679335.0020	3082941.1720	J-21S		Manual	T
679252.7130	3082781.0290	J-22S		Manual	T
679297.0010	3082840.6970	J-23S		Manual	T
679394.8070	3082971.8300	J-24S		Manual	T
679146.6460	3082549.7640	J-25S		Manual	T
679224.5850	3082683.1400	J-26S		Manual	T
679169.0760	3082537.3510	J-27S		Manual	T
679272.0040	3082652.6750	J-28S		Manual	T
679329.4380	3082711.0960	J-29S		Manual	T
679374.4420	3082791.3300	J-30S		Manual	T
679410.1490	3082845.8460	J-31S		Manual	T
679453.4760	3082914.1150	J-32S		Manual	T
679495.8840	3082940.9730	J-33S		Manual	T
679304.6530	3082548.6880	J-34S		Manual	T
679342.7410	3082605.3190	J-35S		Manual	T
679382.8900	3082667.5270	J-36S		Manual	T
679433.9450	3082731.6820	J-37S		Manual	T
679470.3570	3082776.7350	J-38S		Manual	T
679497.3310	3082840.3960	J-39S		Manual	T
679524.3310	3082886.8990	J-40S		Manual	T
679560.6070	3082897.2580	J-41S		Manual	T
679133.4290	3083306.3130	J-01S		Manual	T
679104.2450	3083223.2620	J-02S		Manual	T
679155.0740	3083294.6960	J-03S		Manual	T
679171.2970	3083289.7960	J-04S		Manual	T
679225.8560	3083359.9740	J-05S		Manual	T
679164.8060	3083214.7100	J-06S		Manual	T
679242.7260	3083326.5280	J-07S		Manual	T
679181.2750	3083178.2880	J-08S		Manual	T
679213.7730	3083224.9730	J-09S		Manual	T
679280.5440	3083305.6810	J-10S		Manual	T
679268.7700	3083200.3260	J-11S		Manual	T
679301.1600	3083254.0340	J-12S		Manual	T

Primary Sampling Objective
The primary purpose of sampling at this site is to compare a mean value of a site with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the mean value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the mean value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative hypothesis, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach
A parametric random sampling approach was used to determine the number of samples and to specify sampling locations. A parametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that parametric assumptions are reasonable. These assumptions will be examined in post-sampling data analysis.

Both parametric and non-parametric approaches rely on assumptions about the population. However, non-parametric approaches typically require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than the number of samples required by non-parametric approaches.

Locating the sample points randomly provides data that are separated by many distances, whereas systematic samples are all equidistant apart. Therefore, random sampling provides more information about the spatial structure of the potential contamination than systematic sampling does. As with systematic sampling, random sampling also provides information regarding the mean value, but there is the possibility that areas of the site will not be represented with the same frequency as if uniform grid sampling were performed.

Number of Total Samples: Calculation Equation and Inputs
The equation used to calculate the number of samples is based on a Student's t-test. For this site, the null hypothesis is rejected in favor of the alternative hypothesis if the sample mean is sufficiently smaller than the threshold. The number of samples to collect is calculated so that 1) there will be a high probability ($1-\beta$) of rejecting the null hypothesis if the alternative hypothesis is true and 2) a low probability (α) of rejecting the null hypothesis if the null hypothesis is true.

The formula used to calculate the number of samples is:

$$n = \frac{S^2}{\Delta^2}\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2 + 0.5Z_{1-\alpha}^2$$

where
n is the number of samples,
S is the estimated standard deviation of the measured values including analytical error,
Δ is the width of the gray region,
α is the acceptable probability of incorrectly concluding the site mean is less than the threshold,
β is the acceptable probability of incorrectly concluding the site mean exceeds the threshold,
$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is $1-\alpha$,
$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is $1-\beta$.

The values of these inputs that result in the calculated number of sampling locations are:

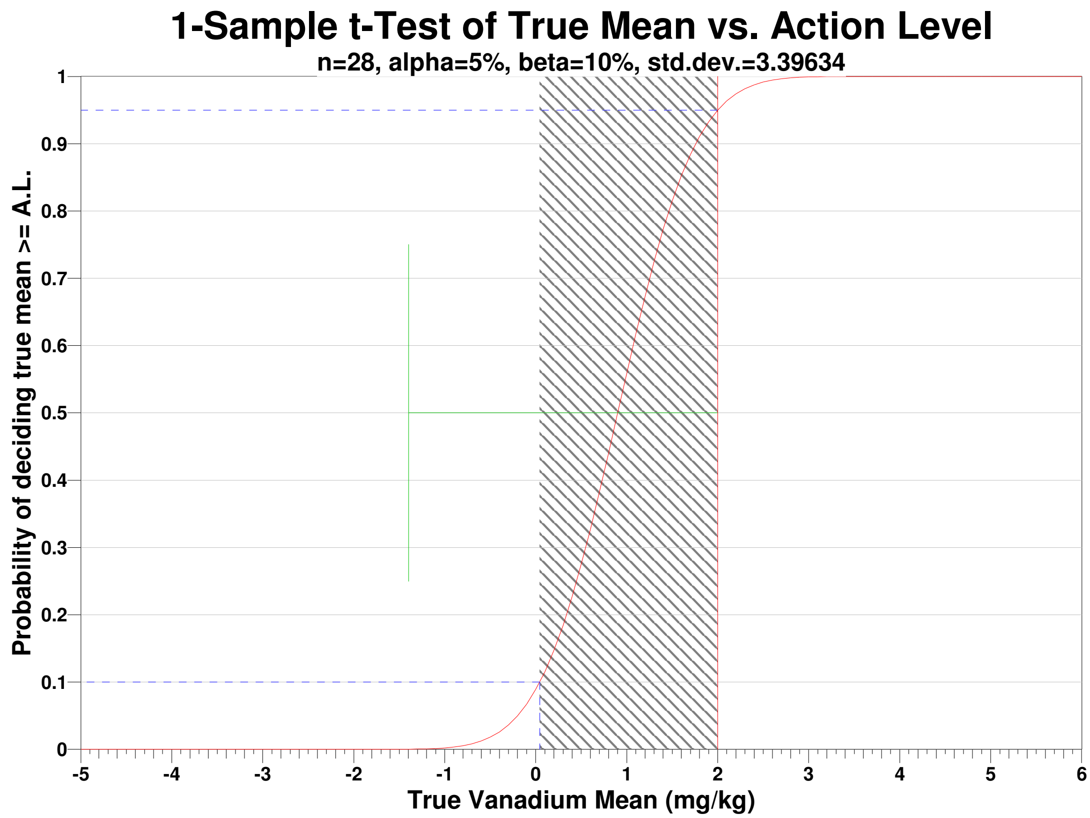
Analyte	n	Parameter					
		S	Δ	α	β	$Z_{1-\alpha}$ [a]	$Z_{1-\beta}$ [b]
New Location	2	0.1 mg/kg	10 mg/kg	0.05	0.1	1.64485	1.28155
Arsenic	2	0.583684 mg/kg	17.3641 mg/kg	0.05	0.1	1.64485	1.28155
Barium	2	25.3192 mg/kg	299.455 mg/kg	0.05	0.1	1.64485	1.28155
Beryllium	2	0.10236 mg/kg	9.88591 mg/kg	0.05	0.1	1.64485	1.28155
Chromium	10	2.69493 mg/kg	2.68878 mg/kg	0.05	0.1	1.64485	1.28155
Cobalt	2	0.499145 mg/kg	12.441 mg/kg	0.05	0.1	1.64485	1.28155
Copper	2	1.26381 mg/kg	59.5155 mg/kg	0.05	0.1	1.64485	1.28155
Diethyl phthalate	2	0.0507891 mg/kg	99.9542 mg/kg	0.05	0.1	1.64485	1.28155
Lead	2	3.95601 mg/kg	116.248 mg/kg	0.05	0.1	1.64485	1.28155
Manganese	2	53.722 mg/kg	457.167 mg/kg	0.05	0.1	1.64485	1.28155
Mercury	15	0.0917868 mg/kg	0.0752202 mg/kg	0.05	0.1	1.64485	1.28155
Nickel	2	1.42019 mg/kg	28.6652 mg/kg	0.05	0.1	1.64485	1.28155

Vanadium	28	3.39634 mg/kg	1.95634 mg/kg	0.05	0.1	1.64485	1.28155
Zinc	2	5.98673 mg/kg	112.59 mg/kg	0.05	0.1	1.64485	1.28155

[a] This value is automatically calculated by VSP based upon the user defined value of α.
[b] This value is automatically calculated by VSP based upon the user defined value of β.

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000) for Vanadium, the driving analyte. It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true mean values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at 1-α on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at 1-α. If any of the inputs change, the number of samples that result in the correct curve changes.



Statistical Assumptions
The assumptions associated with the formulas for computing the number of samples are:

1. the sample mean is normally distributed (this happens if the data are roughly symmetric or the sample size is more than 30; for extremely skewed data sets, additional samples may be required for the sample mean to be normally distributed),
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected randomly.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the sample locations were selected using a random process.

Sensitivity Analysis
The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of

gray region (% of action level), beta (%), probability of mistakenly concluding that μ > action level and alpha (%), probability of mistakenly concluding that μ < action level. The following table shows the results of this analysis.

Number of Samples							
AL=120		α=5		α=10		α=15	
		s=11.9735	s=5.98673	s=11.9735	s=5.98673	s=11.9735	s=5.98673
LBGR=90	β=5	38790	9699	30695	7675	25768	6443
	β=10	30695	7675	23547	5888	19259	4815
	β=15	25769	6444	19259	4816	15401	3851
LBGR=80	β=5	9699	2426	7675	1920	6443	1611
	β=10	7675	1920	5888	1473	4815	1205
	β=15	6444	1612	4816	1205	3851	964
LBGR=70	β=5	4312	1079	3412	854	2864	717
	β=10	3412	854	2618	655	2141	536
	β=15	2865	718	2141	536	1712	429

s = Standard Deviation
LBGR = Lower Bound of Gray Region (% of Action Level)
β = Beta (%), Probability of mistakenly concluding that μ > action level
α = Alpha (%), Probability of mistakenly concluding that μ < action level
AL = Action Level (Threshold)

Cost of Sampling
The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that are based on the number of samples collected and measured. Based on the numbers of samples determined above, the estimated total cost of sampling and analysis at this site is $15,000.00, which averages out to a per sample cost of $535.71. The following table summarizes the inputs and resulting cost estimates.

COST INFORMATION			
Cost Details	**Per Analysis**	**Per Sample**	**28 Samples**
Field collection costs		$100.00	$2,800.00
Analytical costs	$400.00	$400.00	$11,200.00
Sum of Field & Analytical costs		**$500.00**	**$14,000.00**
Fixed planning and validation costs			$1,000.00
Total cost			**$15,000.00**

Data Analysis for Arsenic
The following data points were entered by the user for analysis.

Arsenic (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.08	0.09	0.1	0.1	0.105	0.105	0.11	0.115	0.115	0.12
10	0.14	0.23	0.23	0.26	0.29	0.3	0.33	0.34	0.38	0.41
20	0.44	0.47	0.54	0.54	0.58	0.62	0.7	0.74	0.78	0.8
30	0.81	1	1	1.1	1.2	1.4	1.7	1.7	1.7	2.1
40	2.2									

SUMMARY STATISTICS for Arsenic								
n	41							
Min	0.08							
Max	2.2							
Range	2.12							
Mean	0.63585							
Median	0.44							
Variance	0.34069							
StdDev	0.58368							
Std Error	0.091156							
Skewness	1.2458							
Interquartile Range	0.775							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.08	0.091	0.101	0.13	0.44	0.905	1.7	2.06	2.2

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Arsenic			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.68	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8461
Shapiro-Wilk 5% Critical Value	0.94

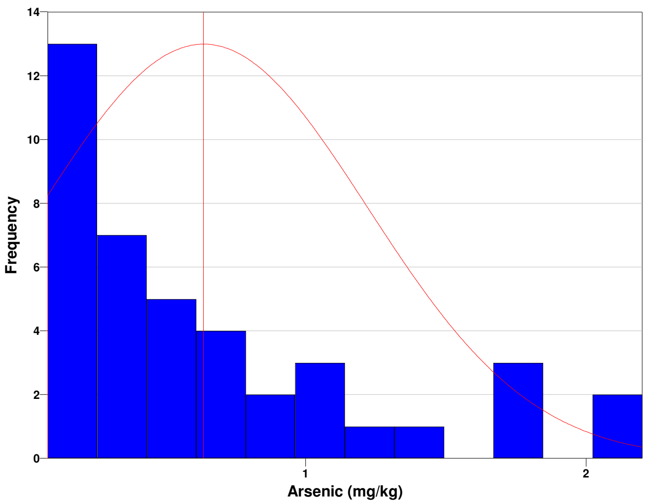
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

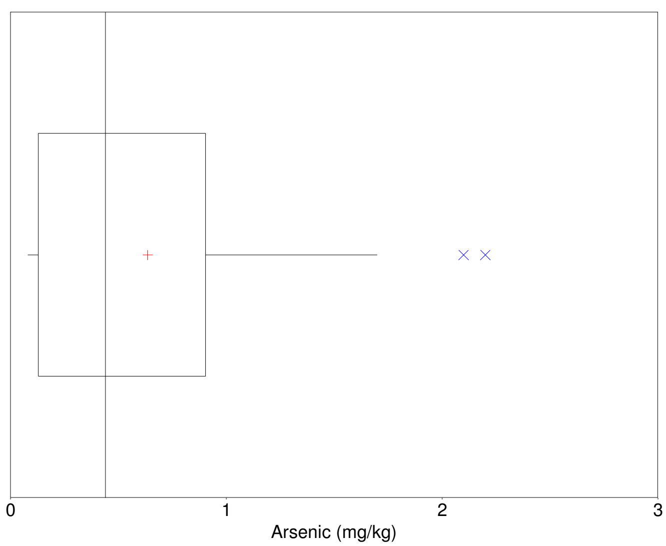
Data Plots for Arsenic
Graphical displays of the data are shown below.

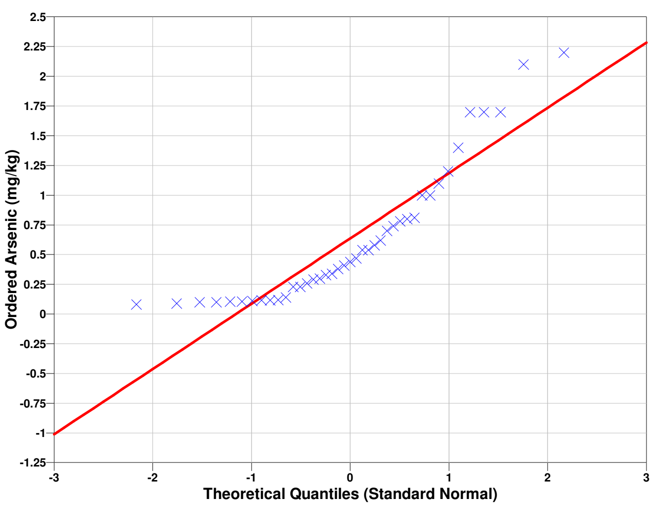
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through

2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Arsenic

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8361
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.7893
95% Non-Parametric (Chebyshev) UCL	1.033

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (1.033) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test

A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where

x is the sample mean of the n=41 data,

AL is the action level or threshold (120),

SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-190.49	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Barium
The following data points were entered by the user for analysis.

Barium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	4.2	4.6	5.4	6.7	7.4	7.7	8.5	8.6	9.6	10.2
10	11.4	11.5	11.8	12	12.4	13.5	16.3	21.5	23.1	23.5
20	25	25.1	25.2	26.4	26.5	29.3	31.1	36.2	39.1	39.6
30	41.8	47.2	47.5	50.6	52.4	59.7	66.9	77.7	78.7	97.8
40	98.7									

SUMMARY STATISTICS for Barium								
n	41							
Min	4.2							
Max	98.7							
Range	94.5							
Mean	30.546							
Median	25							
Variance	641.13							
StdDev	25.321							
Std Error	3.9544							
Skewness	1.2462							
Interquartile Range	33.7							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
4.2	4.68	6.84	10.8	25	44.5	75.54	95.89	98.7

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Barium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.692	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is

recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8687
Shapiro-Wilk 5% Critical Value	0.94

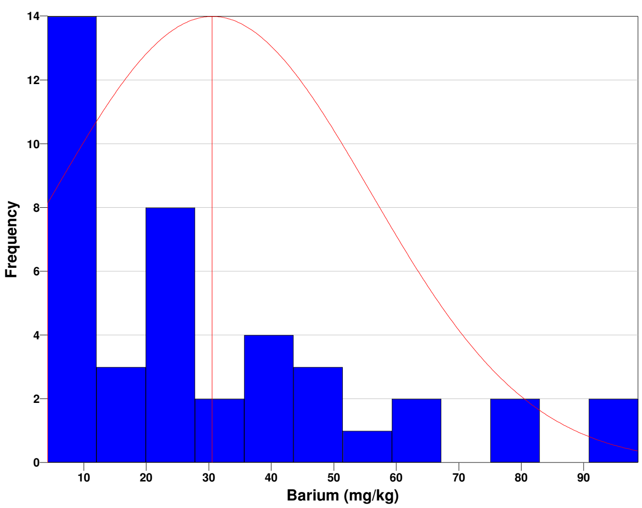
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

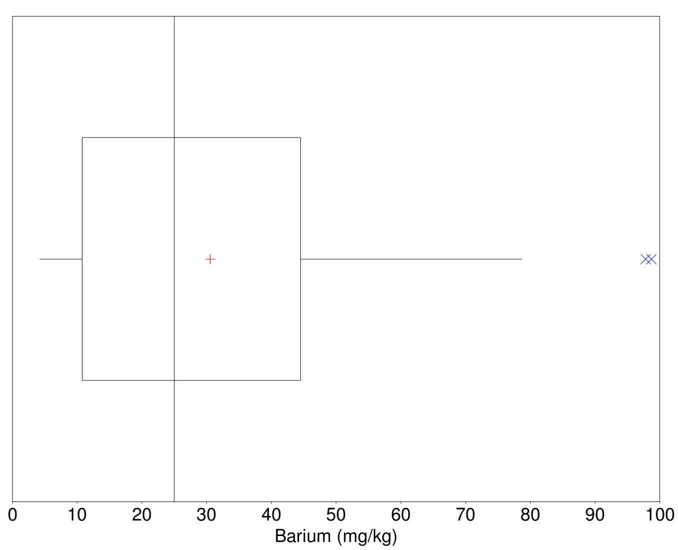
Data Plots for Barium
Graphical displays of the data are shown below.

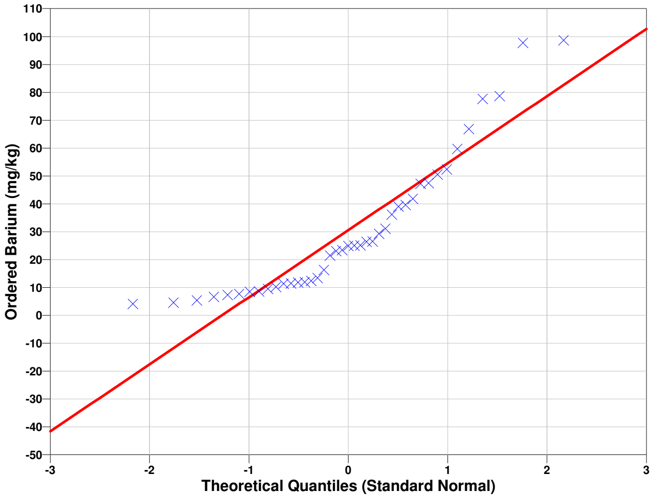
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Barium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8521
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	37.2
95% Non-Parametric (Chebyshev) UCL	47.78

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (47.78) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-75.726	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Beryllium
The following data points were entered by the user for analysis.

Beryllium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.009	0.0115	0.0115	0.012	0.013	0.014	0.023	0.023	0.035	0.035
10	0.041	0.042	0.044	0.0445	0.047	0.054	0.064	0.064	0.067	0.086
20	0.097	0.1	0.1	0.1	0.11	0.11	0.11	0.12	0.13	0.13
30	0.15	0.15	0.19	0.21	0.25	0.27	0.28	0.29	0.3	0.32
40	0.42									

SUMMARY STATISTICS for Beryllium	
n	41
Min	0.009
Max	0.42
Range	0.411
Mean	0.11409
Median	0.097
Variance	0.010478
StdDev	0.10236
Std Error	0.015986
Skewness	1.2312
Interquartile Range	0.112

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.009	0.0115	0.0122	0.038	0.097	0.15	0.288	0.318	0.42

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Beryllium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.989	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8565
Shapiro-Wilk 5% Critical Value	0.94

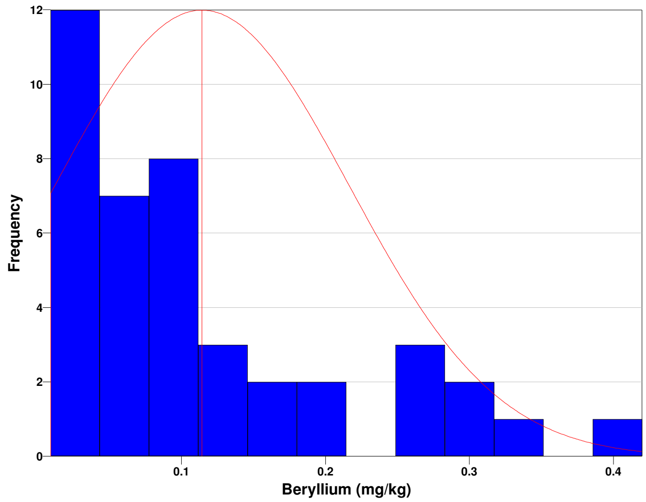
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

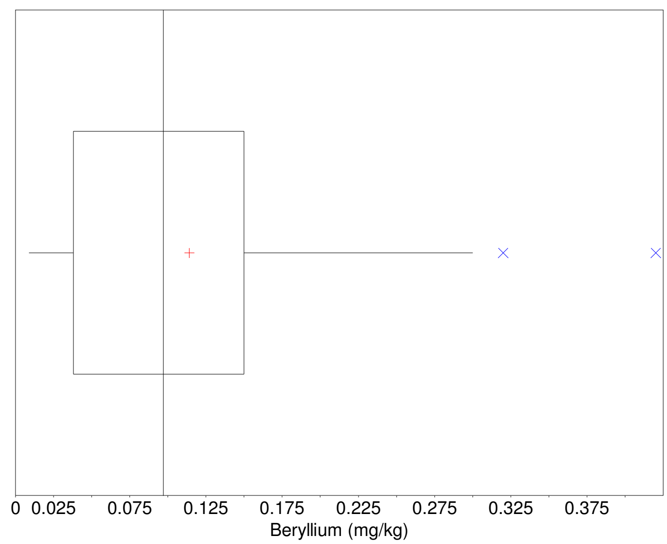
Data Plots for Beryllium
Graphical displays of the data are shown below.

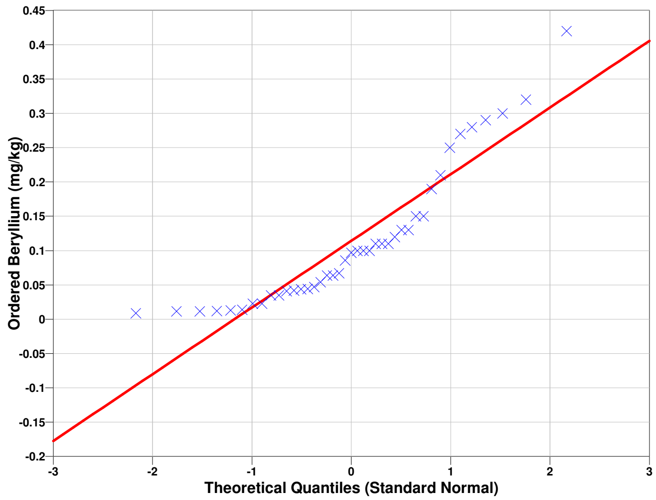
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Beryllium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8553
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.141

95% Non-Parametric (Chebyshev) UCL	0.1838

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.1838) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-618.41	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Chromium
The following data points were entered by the user for analysis.

Chromium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.58	0.59	0.6	0.63	0.76	0.8	0.98	1	1.2	1.2
10	1.4	1.5	1.7	1.8	1.8	1.9	2.1	2.2	2.2	2.3
20	2.4	2.5	2.5	2.7	2.9	3.2	3.2	3.4	3.5	3.7
30	3.7	3.9	4.1	4.3	4.9	5.2	6	6.1	7.4	8.8
40	15									

SUMMARY STATISTICS for Chromium	
n	41
Min	0.58
Max	15

Range				14.42				
Mean				3.0888				
Median				2.4				
Variance				7.2627				
StdDev				2.6949				
Std Error				0.42088				
Skewness				2.5355				
Interquartile Range				2.5				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.58	0.591	0.656	1.3	2.4	3.8	6.08	8.66	15

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Chromium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.42	3.05	Yes

The test statistic 4.42 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Chromium	
1	15

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8953
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

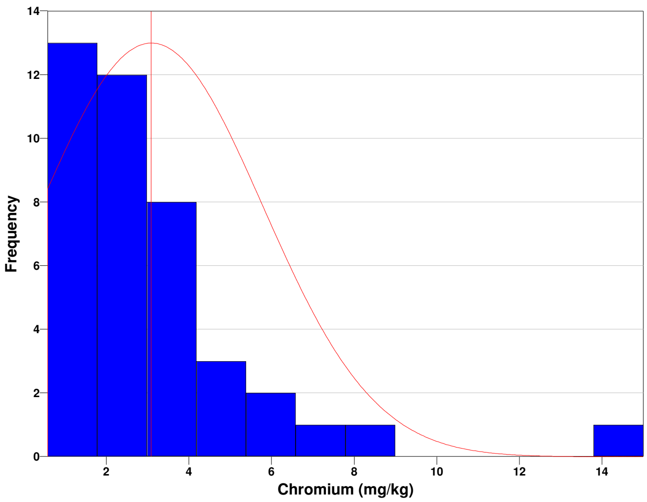
Data Plots for Chromium
Graphical displays of the data are shown below.

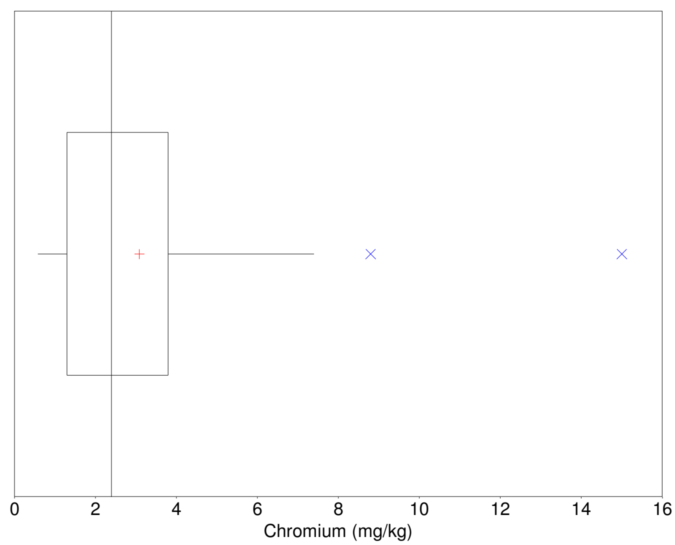
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

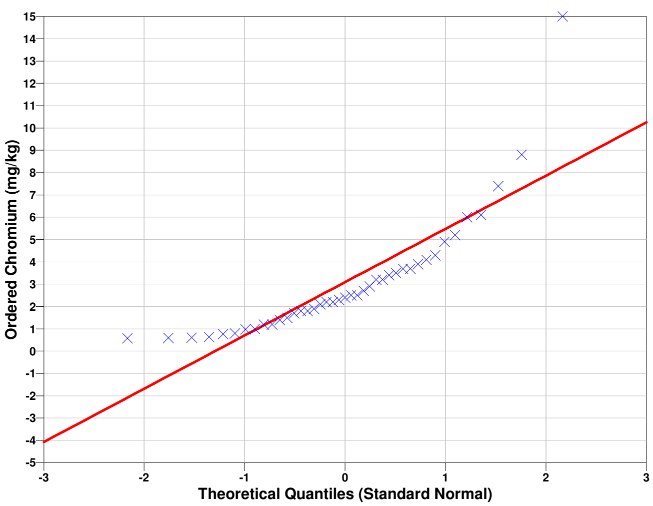
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Chromium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7725
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	3.797
95% Non-Parametric (Chebyshev) UCL	4.923

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (4.923) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
6.3885	1.6839	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
0	26	Cannot Reject
Note: There may not be enough data to reject the null hypothesis (and conclude site is clean) with 95% confidence using the MARSSIM sign test.		

Data Analysis for Cobalt
The following data points were entered by the user for analysis.

Cobalt (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.07	0.08	0.09	0.09	0.095	0.095	0.095	0.1	0.1	0.105
10	0.11	0.125	0.24	0.25	0.26	0.31	0.34	0.35	0.39	0.44
20	0.48	0.5	0.55	0.56	0.56	0.58	0.58	0.61	0.69	0.715
30	0.72	0.73	0.78	0.84	0.99	1.1	1.2	1.5	1.7	1.9
40	1.9									

SUMMARY STATISTICS for Cobalt								
n	41							
Min	0.07							
Max	1.9							
Range	1.83							
Mean	0.55902							
Median	0.48							
Variance	0.24915							
StdDev	0.49914							
Std Error	0.077953							
Skewness	1.3458							
Interquartile Range	0.6175							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.07	0.081	0.091	0.1075	0.48	0.725	1.44	1.88	1.9

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Cobalt			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.687	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is

recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8517
Shapiro-Wilk 5% Critical Value	0.94

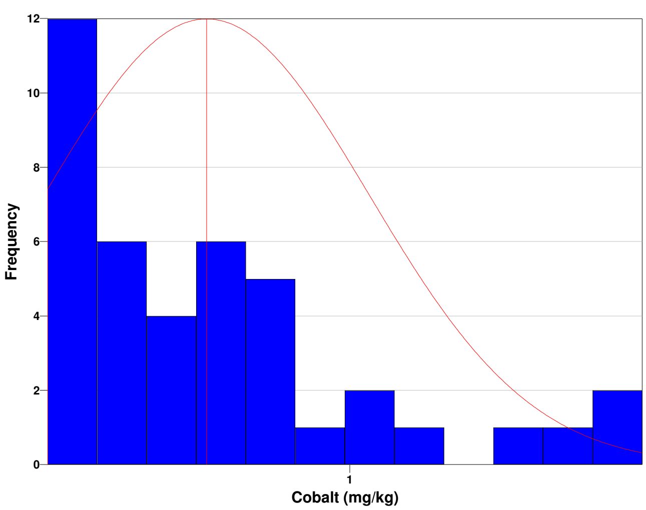
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

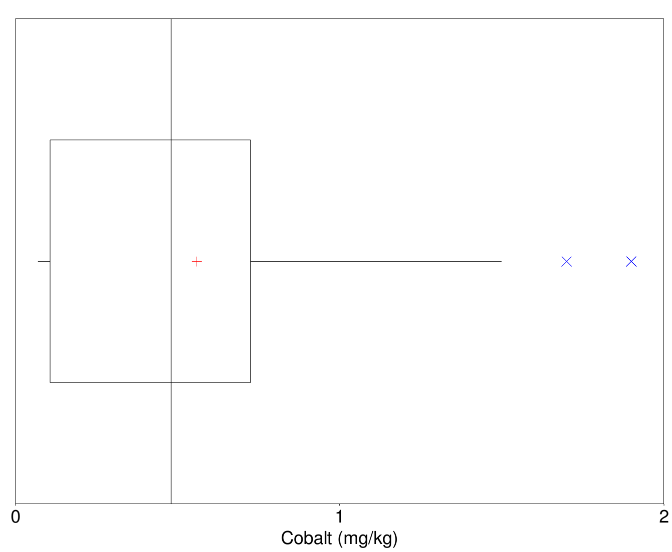
Data Plots for Cobalt
Graphical displays of the data are shown below.

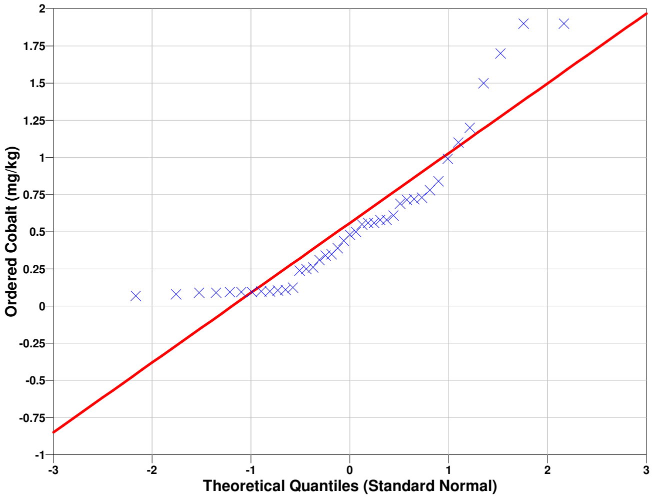
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Cobalt
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.835
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.6903
95% Non-Parametric (Chebyshev) UCL	0.8988

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.8988) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-159.6	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Copper
The following data points were entered by the user for analysis.

Copper (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.35	0.39	0.39	0.44	0.45	0.47	0.48	0.49	0.58	0.59
10	0.61	0.62	0.72	0.725	0.79	0.89	0.9	0.92	0.96	1
20	1.1	1.1	1.2	1.2	1.3	1.3	1.5	1.6	1.7	1.8
30	1.9	1.9	1.9	2	2.1	2.4	3.8	3.9	4.1	4.4
40	5.9									

SUMMARY STATISTICS for Copper								
n	41							
Min	0.35							
Max	5.9							
Range	5.55							
Mean	1.4845							
Median	1.1							
Variance	1.5972							
StdDev	1.2638							
Std Error	0.19737							
Skewness	1.8525							
Interquartile Range	1.3							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.35	0.39	0.442	0.6	1.1	1.9	3.88	4.37	5.9

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Copper			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.494	3.05	Yes

The test statistic 3.494 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Copper	
1	5.9

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8002
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

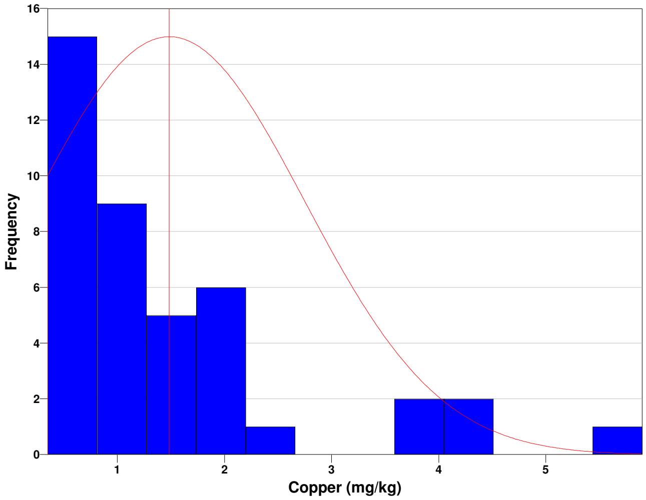
Data Plots for Copper
Graphical displays of the data are shown below.

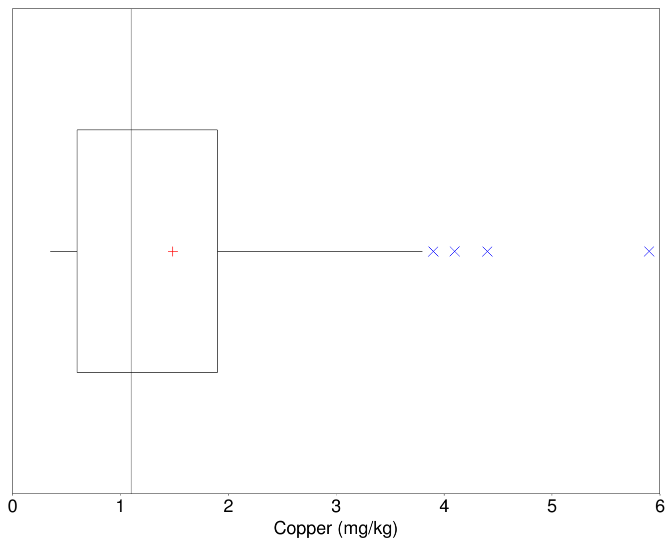
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

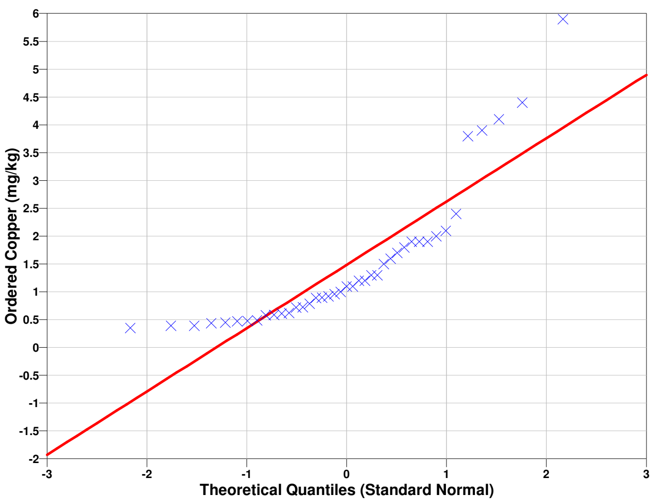
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the

Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Copper
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7798
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	1.817
95% Non-Parametric (Chebyshev) UCL	2.345

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (2.345) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-301.54	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Diethyl phthalate
The following data points were entered by the user for analysis.

Diethyl phthalate (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.024	0.026	0.026	0.026	0.0265	0.0265	0.0265	0.0265	0.027	0.027
10	0.027	0.027	0.027	0.027	0.027	0.027	0.0275	0.0275	0.0275	0.0275
20	0.0275	0.0275	0.028	0.0285	0.0285	0.0285	0.0285	0.029	0.029	0.0295
30	0.0295	0.0305	0.031	0.0315	0.0763	0.0952	0.101	0.111	0.12	0.123
40	0.31									

SUMMARY STATISTICS for Diethyl phthalate	
n	41

Min				0.024				
Max				0.31				
Range				0.286				
Mean				0.045793				
Median				0.0275				
Variance				0.0025795				
StdDev				0.050789				
Std Error				0.0079319				
Skewness				3.952				
Interquartile Range				0.003				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.024	0.026	0.0261	0.027	0.0275	0.03	0.109	0.1227	0.31

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Diethyl phthalate			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.202	3.05	Yes

The test statistic 5.202 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Diethyl phthalate	
1	0.31

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.4949
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

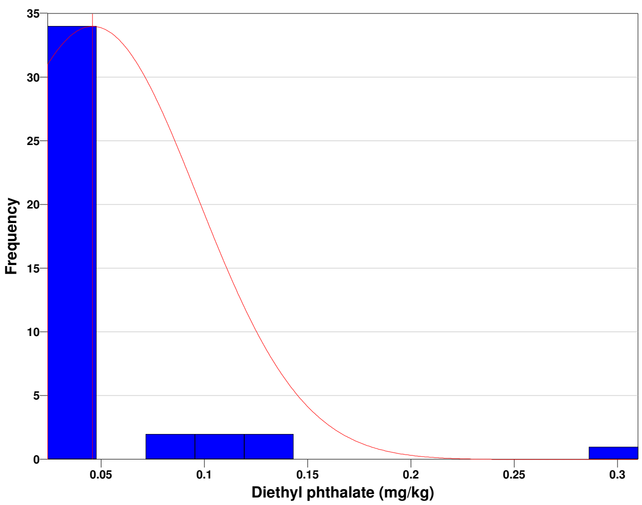
Data Plots for Diethyl phthalate

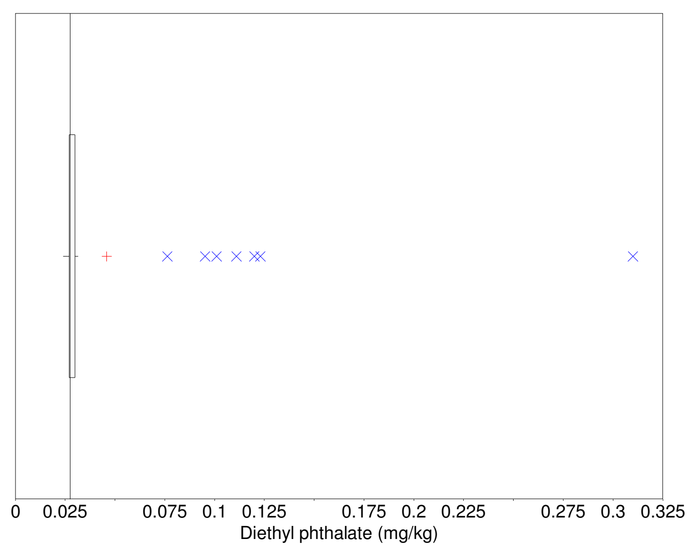
Graphical displays of the data are shown below.

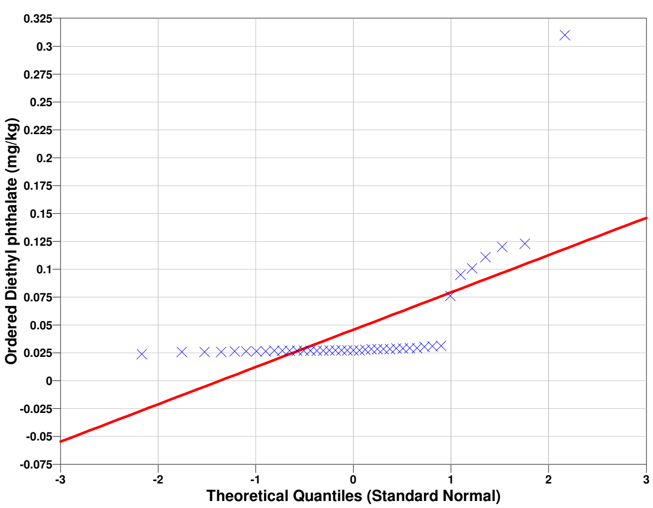
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Diethyl phthalate
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.4472
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.05915
95% Non-Parametric (Chebyshev) UCL	0.08037

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.08037) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-12601	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**

41	26	Reject

Data Analysis for Lead
The following data points were entered by the user for analysis.

Lead (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1.3	1.5	1.5	1.6	1.7	1.7	1.8	1.9	1.9	1.9
10	2	2.1	2.15	2.3	2.3	2.3	2.3	2.4	2.5	2.6
20	2.7	2.7	2.7	2.8	3.1	3.2	3.2	3.5	3.6	3.8
30	4.1	4.2	4.2	4.3	5.7	5.9	6	6.3	6.8	9.3
40	26									

SUMMARY STATISTICS for Lead	
n	41
Min	1.3
Max	26
Range	24.7
Mean	3.7524
Median	2.7
Variance	15.65
StdDev	3.956
Std Error	0.61782
Skewness	4.7237
Interquartile Range	2.2

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
1.3	1.5	1.62	1.95	2.7	4.15	6.24	9.05	26

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Lead			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.624	3.05	Yes

The test statistic 5.624 exceeded the corresponding critical value, therefore that test is significant and we conclude that the

most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Lead	
1	26

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.835
Shapiro-Wilk 5% Critical Value	0.94

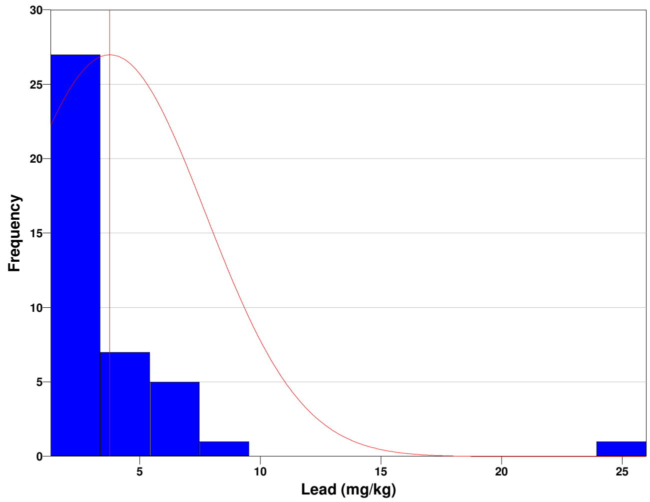
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

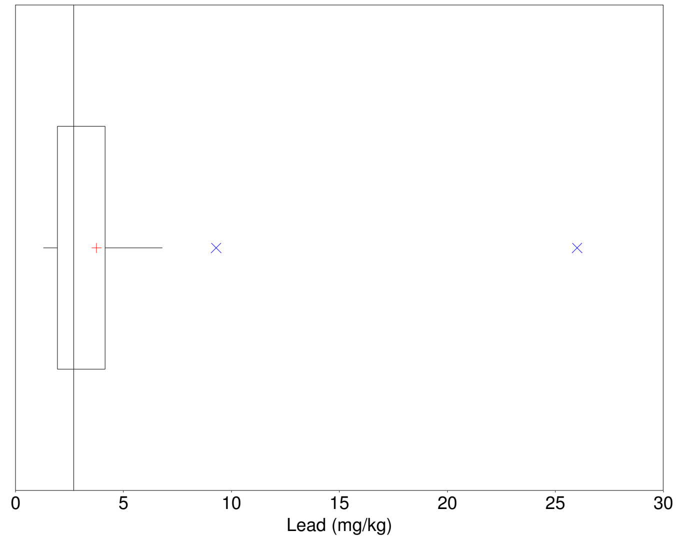
Data Plots for Lead
Graphical displays of the data are shown below.

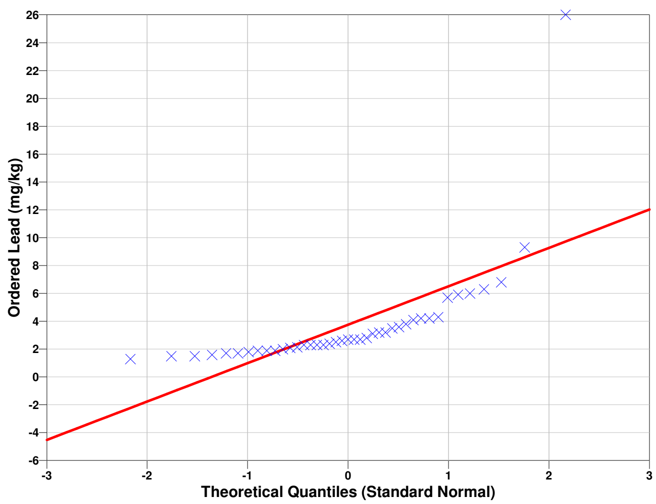
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Lead

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5047
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	4.793

95% Non-Parametric (Chebyshev) UCL	6.445

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (6.445) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-188.16	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Manganese
The following data points were entered by the user for analysis.

Manganese (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	2.7	3.1	3.5	4.1	4.4	4.5	4.6	5.1	5.5	6.2
10	7.5	9	9.1	9.9	9.9	10.1	10.8	11.9	12.9	13.9
20	17.2	17.8	19.7	21.3	29	31.7	36	49.3	51.3	54.3
30	69.5	70.1	73	75	76.3	112	130	134	146	153
40	241									

SUMMARY STATISTICS for Manganese	
n	41
Min	2.7
Max	241

Range				238.3				
Mean				42.834				
Median				17.2				
Variance				2886.1				
StdDev				53.723				
Std Error				8.3901				
Skewness				1.8878				
Interquartile Range				62.95				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
2.7	3.14	4.16	6.85	17.2	69.8	133.2	152.3	241

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Manganese			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.689	3.05	Yes

The test statistic 3.689 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Manganese	
1	241

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7607
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

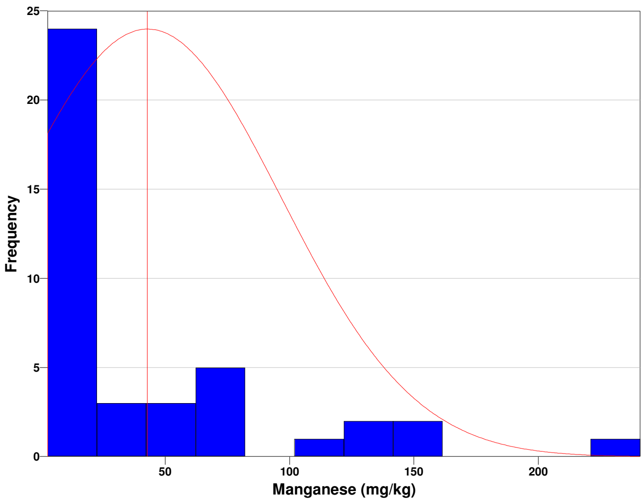
Data Plots for Manganese
Graphical displays of the data are shown below.

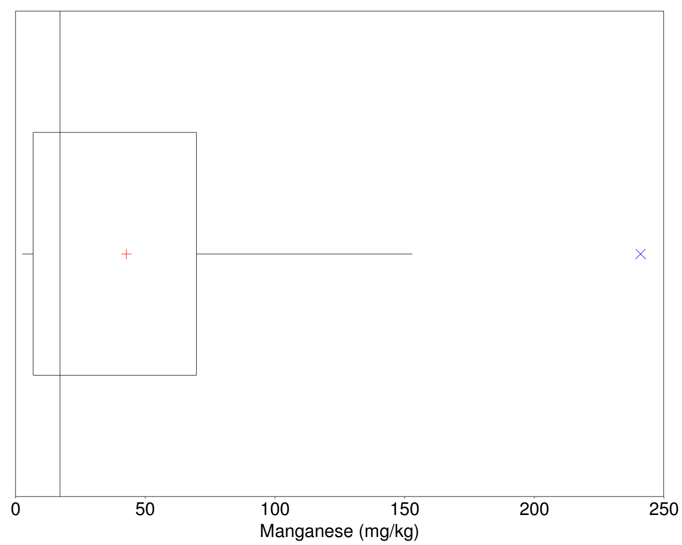
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

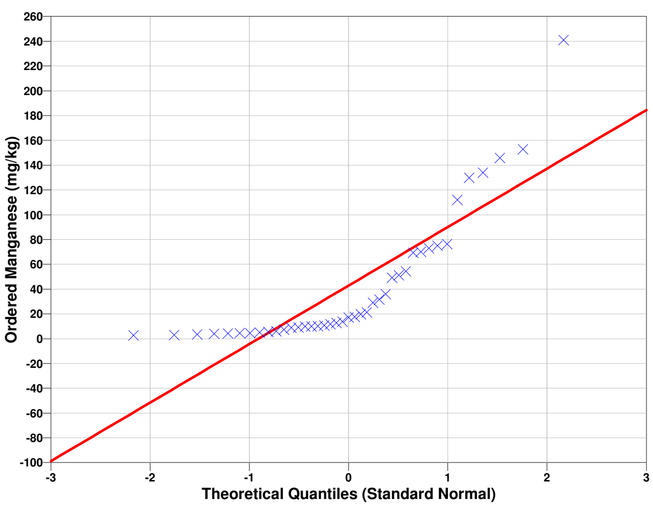
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Manganese

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7451
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	56.96
95% Non-Parametric (Chebyshev) UCL	79.41

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (79.41) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test

A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where

x is the sample mean of the n=41 data,

AL is the action level or threshold (120),

SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-54.489	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Mercury
The following data points were entered by the user for analysis.

Mercury (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00035	0.00036	0.000365	0.00038	0.00038	0.00038	0.000385	0.00043	0.00044	0.0013
10	0.0017	0.0021	0.0024	0.0025	0.0026	0.0038	0.0043	0.0045	0.0046	0.0048
20	0.0048	0.0051	0.0053	0.0065	0.0072	0.0073	0.0077	0.008	0.01	0.011
30	0.012	0.012	0.013	0.014	0.019	0.033	0.048	0.054	0.055	0.055
40	0.59									

SUMMARY STATISTICS for Mercury	
n	41
Min	0.00035
Max	0.59
Range	0.58965
Mean	0.02478
Median	0.0048
Variance	0.0084248
StdDev	0.091787
Std Error	0.014335
Skewness	6.13
Interquartile Range	0.0105

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00035	0.0003605	0.00038	0.0015	0.0048	0.012	0.0528	0.055	0.59

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Mercury			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	6.158	3.05	Yes

The test statistic 6.158 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Mercury

1	0.59

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6364
Shapiro-Wilk 5% Critical Value	0.94

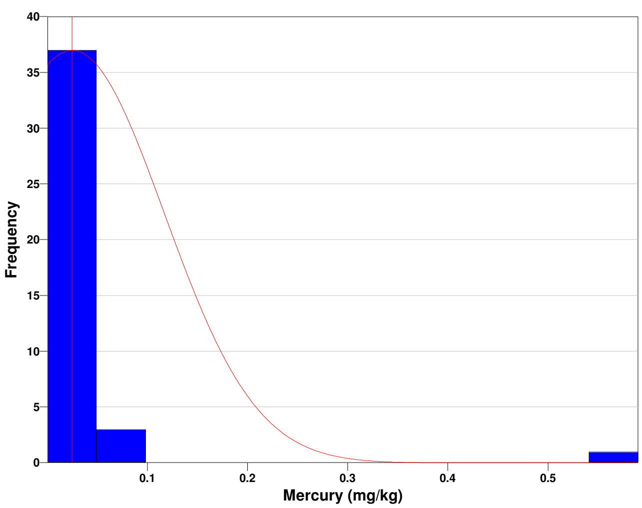
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

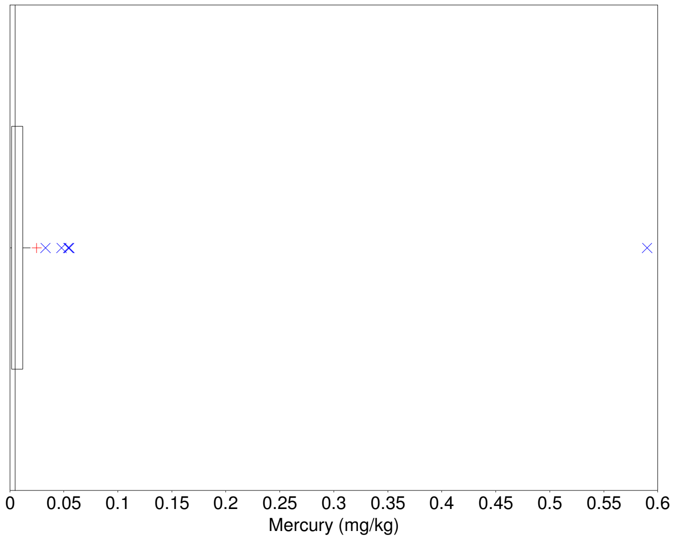
Data Plots for Mercury
Graphical displays of the data are shown below.

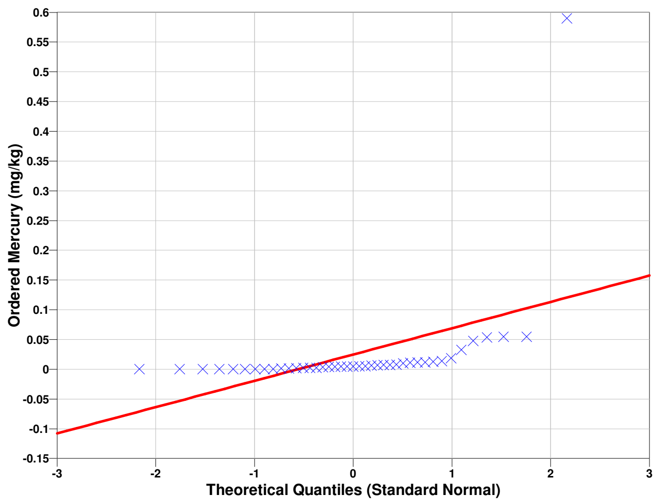
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Mercury
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.2612
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.04892

95% Non-Parametric (Chebyshev) UCL	0.08726

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.08726) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-5.2474	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
40	26	Reject

Data Analysis for Nickel
The following data points were entered by the user for analysis.

Nickel (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.06	0.065	0.08	0.18	0.21	0.22	0.22	0.23	0.26	0.26
10	0.28	0.29	0.32	0.36	0.36	0.39	0.46	0.66	0.73	0.99
20	1	1.1	1.3	1.3	1.4	1.4	1.4	1.5	1.5	1.8
30	1.8	1.8	1.8	1.8	2.4	2.6	2.9	3.6	4	5.8
40	5.9									

SUMMARY STATISTICS for Nickel	
n	41
Min	0.06
Max	5.9

Range	5.84
Mean	1.3348
Median	1
Variance	2.0169
StdDev	1.4202
Std Error	0.2218
Skewness	1.8288
Interquartile Range	1.53

Percentiles

1%	5%	10%	25%	50%	75%	90%	95%	99%
0.06	0.0665	0.186	0.27	1	1.8	3.46	5.62	5.9

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Nickel			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.215	3.05	Yes

The test statistic 3.215 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Nickel	
1	5.9

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8158
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

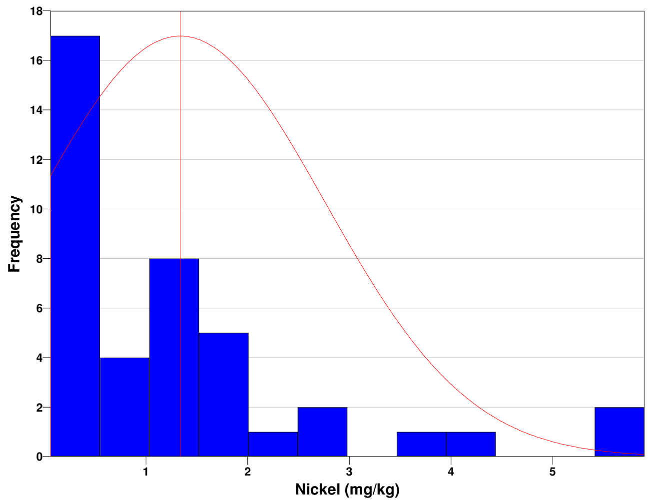
Data Plots for Nickel
Graphical displays of the data are shown below.

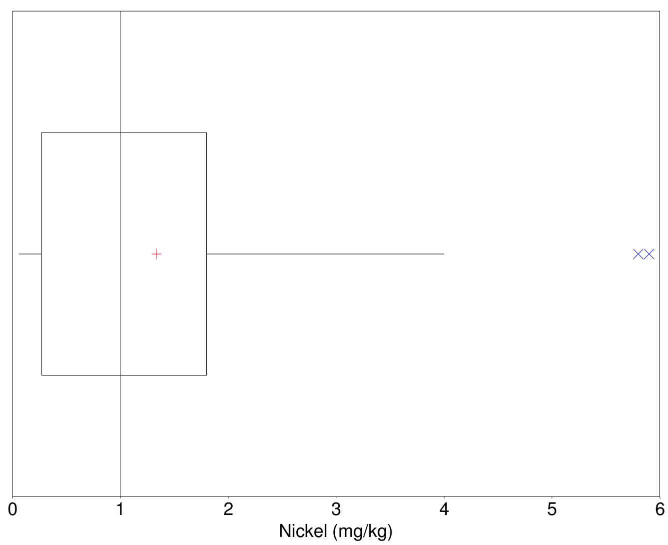
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

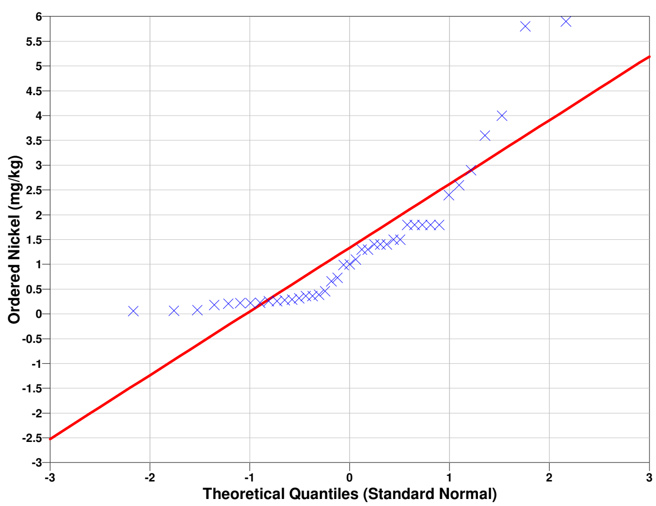
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Nickel
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.784
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	1.708
95% Non-Parametric (Chebyshev) UCL	2.302

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (2.302) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-129.24	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Vanadium
The following data points were entered by the user for analysis.

Vanadium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.65	0.77	0.83	0.89	0.95	0.97	1	1.1	1.2	1.3
10	1.7	1.7	1.8	1.95	2	2.1	2.3	2.4	2.4	2.4
20	2.9	3.1	3.2	3.6	3.7	3.8	4.3	4.4	4.5	5
30	5.3	5.7	5.8	6	6.7	6.9	7.1	11	12.1	13
40	13.7									

SUMMARY STATISTICS for Vanadium								
n	41							
Min	0.65							
Max	13.7							
Range	13.05							
Mean	3.9563							
Median	2.9							
Variance	11.535							
StdDev	3.3963							
Std Error	0.53042							
Skewness	1.5509							
Interquartile Range	4							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.65	0.776	0.902	1.5	2.9	5.5	10.22	12.91	13.7

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Vanadium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.869	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the

suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8286
Shapiro-Wilk 5% Critical Value	0.94

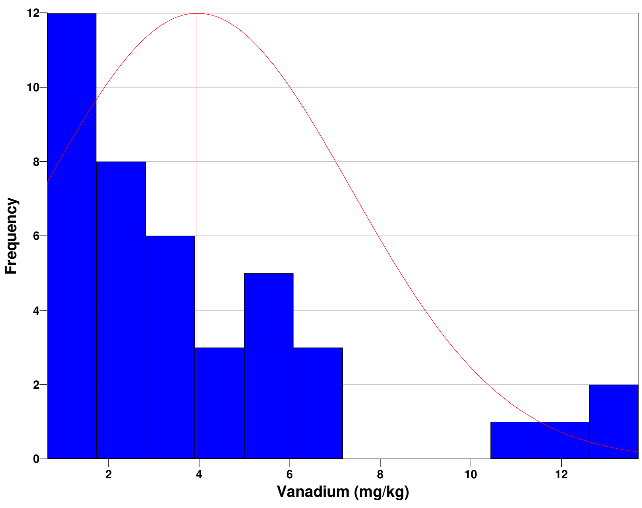
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

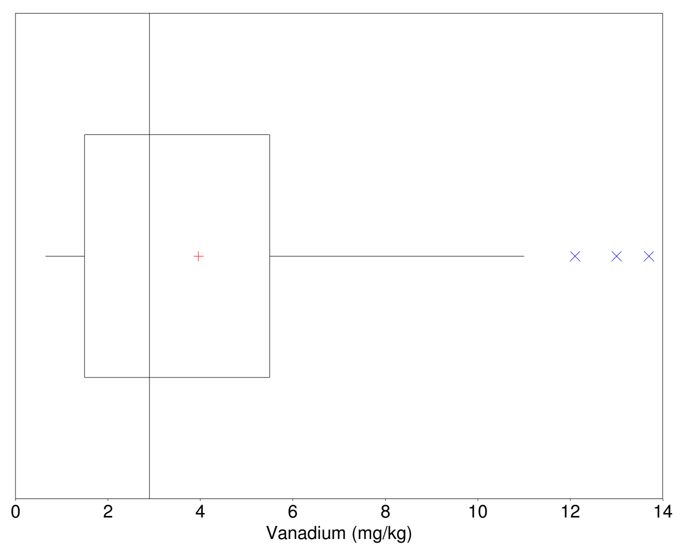
Data Plots for Vanadium
Graphical displays of the data are shown below.

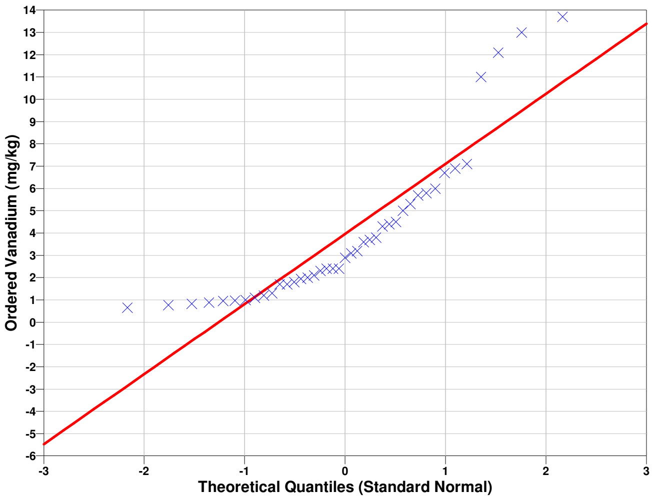
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Vanadium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8131
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	4.849
95% Non-Parametric (Chebyshev) UCL	6.268

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (6.268) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
3.6883	1.6839	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
14	25	Cannot Reject
Note: There may not be enough data to reject the null hypothesis (and conclude site is clean) with 95% confidence using the MARSSIM sign test.		

Data Analysis for Zinc
The following data points were entered by the user for analysis.

Zinc (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1.5	1.5	1.6	1.6	2.1	2.2	2.3	2.3	2.8	2.8
10	2.9	3.1	3.1	3.2	3.6	4.4	4.4	5.4	5.7	6.4
20	6.5	6.7	7	7	7.1	7.2	7.3	7.3	7.4	8.1
30	8.3	10.3	10.3	11	11	15	16.6	18.9	19.5	23.6
40	24.8									

SUMMARY STATISTICS for Zinc	
n	41
Min	1.5
Max	24.8
Range	23.3
Mean	7.4098
Median	6.5
Variance	35.841
StdDev	5.9867
Std Error	0.93497
Skewness	1.486
Interquartile Range	6.45

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**

1.5	1.51	1.7	2.85	6.5	9.3	18.44	23.19	24.8

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Zinc			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.905	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8409
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

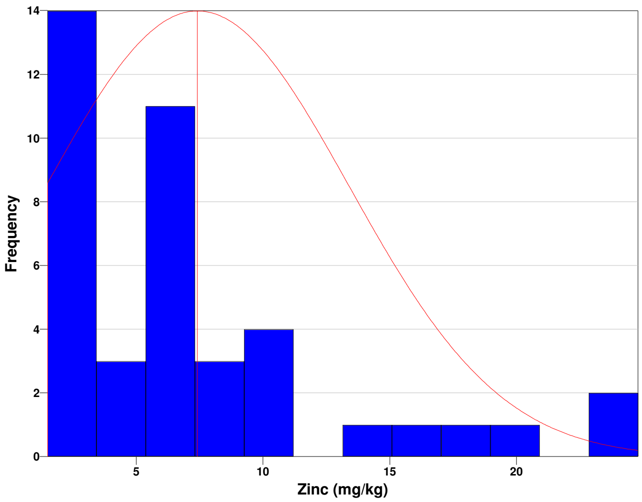
Data Plots for Zinc
Graphical displays of the data are shown below.

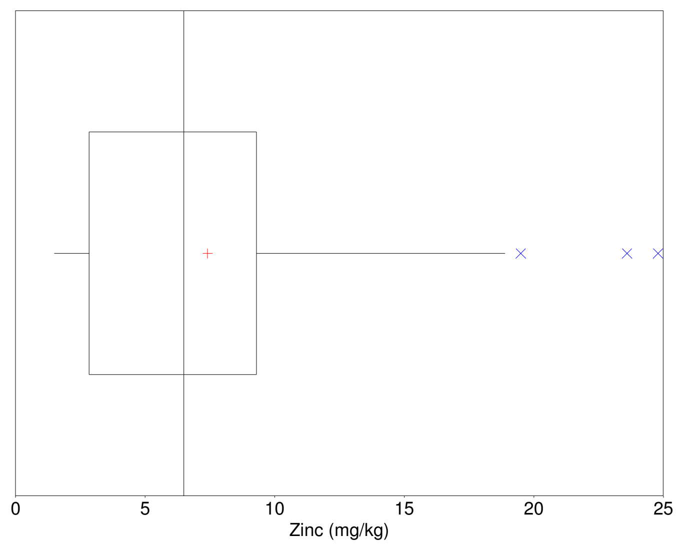
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

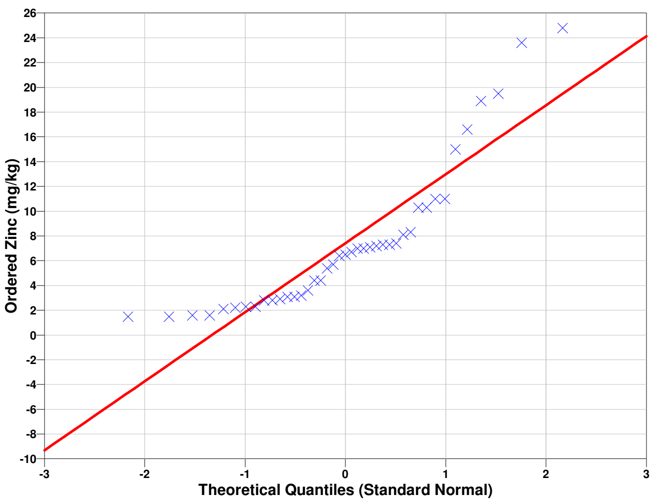
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a

fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Zinc

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.823
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN

95% Parametric UCL	8.984
95% Non-Parametric (Chebyshev) UCL	11.49

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (11.49) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-120.42	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

This report was automatically produced* by Visual Sample Plan (VSP) software version 5.3.1.
Software and documentation available at http://dqo.pnl.gov/vsp

* - The report contents may have been modified or reformatted by end-user of software.

Appendix C

VSP Reports of Calculated Minimum Sample Quantity
Report 8
Area of Concern – 1
Minimum Sample Quantity Calculation for Subsurface Soil using Ecological Benchmarks and Delta Method 2

Random sampling locations for comparing a mean with a fixed threshold (parametric)

Summary
This report summarizes the sampling design, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design for Chromium, the driving analyte (the analyte which required the largest number of samples). A figure that shows sampling locations in the field is also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean to a fixed threshold
Type of Sampling Design	Parametric
Sample Placement (Location) in the Field	Simple random sampling
Working (Null) Hypothesis	The mean value at the site exceeds the threshold
Formula for calculating number of sampling locations	Student's t-test
Calculated total number of samples	1557
Number of samples on map [a]	1557
Number of selected sample areas [b]	1
Specified sampling area [c]	188054.34 m^2
Total cost of sampling [d]	$779,500.00

[a] This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[d] Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.

Primary Sampling Objective
The primary purpose of sampling at this site is to compare a mean value of a site with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the mean value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the mean value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative hypothesis, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach
A parametric random sampling approach was used to determine the number of samples and to specify sampling locations. A parametric formula was chosen because the conceptual model and historical information (e.g., historical data from this

site or a very similar site) indicate that parametric assumptions are reasonable. These assumptions will be examined in post-sampling data analysis.

Both parametric and non-parametric approaches rely on assumptions about the population. However, non-parametric approaches typically require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than the number of samples required by non-parametric approaches.

Locating the sample points randomly provides data that are separated by many distances, whereas systematic samples are all equidistant apart. Therefore, random sampling provides more information about the spatial structure of the potential contamination than systematic sampling does. As with systematic sampling, random sampling also provides information regarding the mean value, but there is the possibility that areas of the site will not be represented with the same frequency as if uniform grid sampling were performed.

Number of Total Samples: Calculation Equation and Inputs
The equation used to calculate the number of samples is based on a Student's t-test. For this site, the null hypothesis is rejected in favor of the alternative hypothesis if the sample mean is sufficiently smaller than the threshold. The number of samples to collect is calculated so that 1) there will be a high probability (1-β) of rejecting the null hypothesis if the alternative hypothesis is true and 2) a low probability (α) of rejecting the null hypothesis if the null hypothesis is true.

The formula used to calculate the number of samples is:

$$n = \frac{S^2}{\Delta^2}\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2 + 0.5Z_{1-\alpha}^2$$

where
n is the number of samples,
S is the estimated standard deviation of the measured values including analytical error,
Δ is the width of the gray region,
α is the acceptable probability of incorrectly concluding the site mean is less than the threshold,
β is the acceptable probability of incorrectly concluding the site mean exceeds the threshold,
$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is 1-α,
$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is 1-β.

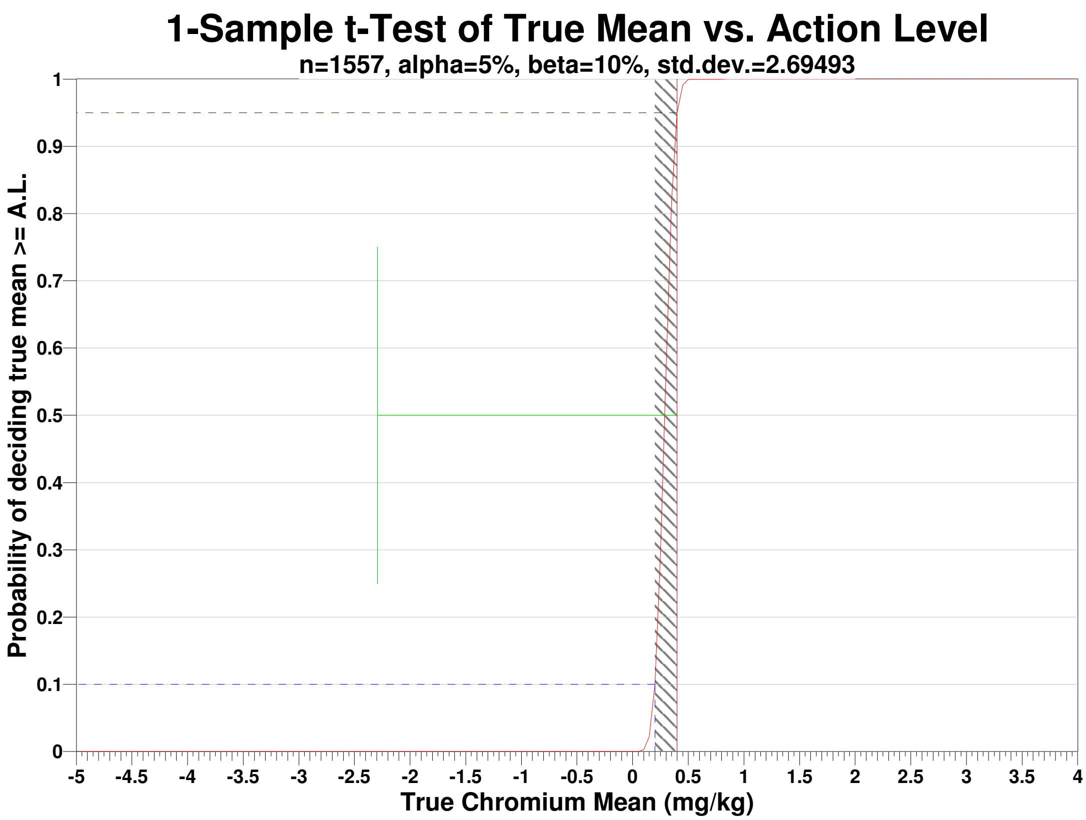
The values of these inputs that result in the calculated number of sampling locations are:

Analyte	**n**	**Parameter**					
		S	**Δ**	**α**	**β**	**$Z_{1-\alpha}$** [a]	**$Z_{1-\beta}$** [b]
New Location	2	0.1 mg/kg	10 mg/kg	0.05	0.1	1.64485	1.28155
Arsenic	2	0.583684 mg/kg	9 mg/kg	0.05	0.1	1.64485	1.28155
Barium	2	25.3192 mg/kg	165 mg/kg	0.05	0.1	1.64485	1.28155
Beryllium	2	0.10236 mg/kg	5 mg/kg	0.05	0.1	1.64485	1.28155
Chromium	1557	2.69493 mg/kg	0.2 mg/kg	0.05	0.1	1.64485	1.28155
Cobalt	2	0.499145 mg/kg	6.5 mg/kg	0.05	0.1	1.64485	1.28155
Copper	2	1.26381 mg/kg	30.5 mg/kg	0.05	0.1	1.64485	1.28155
Diethyl phthalate	2	0.0507891 mg/kg	50 mg/kg	0.05	0.1	1.64485	1.28155
Lead	2	3.95601 mg/kg	60 mg/kg	0.05	0.1	1.64485	1.28155
Manganese	2	53.722 mg/kg	250 mg/kg	0.05	0.1	1.64485	1.28155
Mercury	31	0.0917868 mg/kg	0.05 mg/kg	0.05	0.1	1.64485	1.28155
Nickel	2	1.42019 mg/kg	15 mg/kg	0.05	0.1	1.64485	1.28155
Vanadium	101	3.39634 mg/kg	1 mg/kg	0.05	0.1	1.64485	1.28155
Zinc	2	5.98673 mg/kg	60 mg/kg	0.05	0.1	1.64485	1.28155

[a] This value is automatically calculated by VSP based upon the user defined value of α.
[b] This value is automatically calculated by VSP based upon the user defined value of β.

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000) for Chromium, the driving analyte. It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true mean values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at 1-α on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at 1-α. If any of the inputs change, the number of samples that result in the correct curve changes.



Statistical Assumptions
The assumptions associated with the formulas for computing the number of samples are:
1. the sample mean is normally distributed (this happens if the data are roughly symmetric or the sample size is more than 30; for extremely skewed data sets, additional samples may be required for the sample mean to be normally distributed),
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected randomly.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the sample locations were selected using a random process.

Sensitivity Analysis
The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that μ > action level and alpha (%), probability of mistakenly concluding that μ < action level. The following table shows the results of this analysis.

Number of Samples

AL=120		α=5		α=10		α=15	
		s=11.9735	s=5.98673	s=11.9735	s=5.98673	s=11.9735	s=5.98673
LBGR=90	β=5	969694	242425	767342	191837	644179	161046
	β=10	767343	191837	588644	147162	481439	120361
	β=15	644180	161046	481440	120361	385002	96251
LBGR=80	β=5	242425	60608	191837	47960	161046	40262
	β=10	191837	47961	147162	36791	120361	30091
	β=15	161046	40263	120361	30091	96251	24064
LBGR=70	β=5	107745	26938	85261	21316	71576	17895
	β=10	85262	21317	65406	16352	53494	13374
	β=15	71577	17896	53494	13375	42779	10696

s = Standard Deviation
LBGR = Lower Bound of Gray Region (% of Action Level)
β = Beta (%), Probability of mistakenly concluding that μ > action level
α = Alpha (%), Probability of mistakenly concluding that μ < action level
AL = Action Level (Threshold)

Cost of Sampling

The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that are based on the number of samples collected and measured. Based on the numbers of samples determined above, the estimated total cost of sampling and analysis at this site is $779,500.00, which averages out to a per sample cost of $500.64. The following table summarizes the inputs and resulting cost estimates.

COST INFORMATION			
Cost Details	**Per Analysis**	**Per Sample**	**1557 Samples**
Field collection costs		$100.00	$155,700.00
Analytical costs	$400.00	$400.00	$622,800.00
Sum of Field & Analytical costs		**$500.00**	**$778,500.00**
Fixed planning and validation costs			$1,000.00
Total cost			**$779,500.00**

Data Analysis for New Location

SUMMARY STATISTICS for New Location	
n	1516
Min	0
Max	0
Range	0
Mean	0
Median	0
Variance	0
StdDev	0
Std Error	0
Skewness	-1.#IND

Interquartile Range				0				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0	0	0	0	0	0	0	0	0

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for New Location			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	0	-1	Yes

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Lilliefors test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Lilliefors Test Statistic	1.061e+292
Lilliefors 5% Critical Value	1.376e-313

The calculated Lilliefors test statistic exceeds the 5% Lilliefors critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

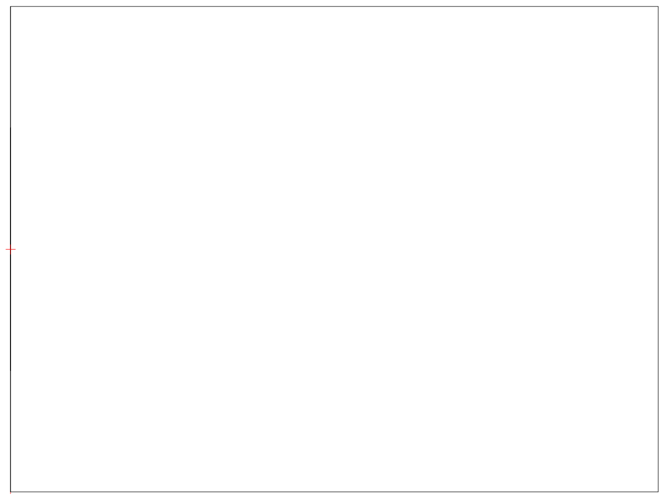
Data Plots for New Location
Graphical displays of the data are shown below.

The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

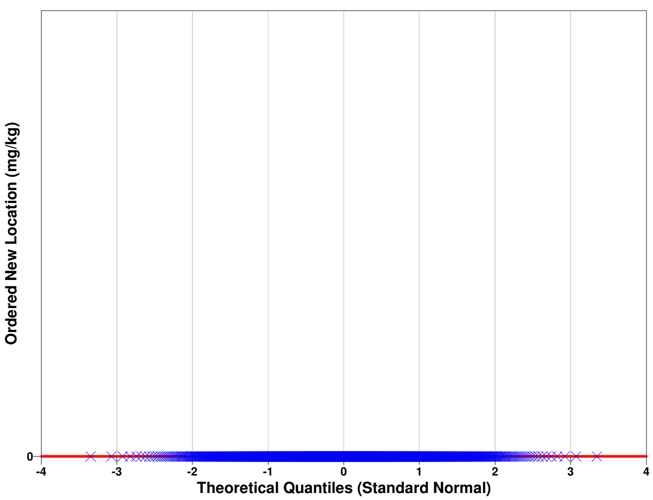
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the

distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.



New Location (mg/kg)



For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for New Location

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Lilliefors test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Lilliefors Test Statistic	0
Lilliefors 5% Critical Value	0.02276

The calculated Lilliefors test statistic is less than the 5% Lilliefors critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0
95% Non-Parametric (Chebyshev) UCL	0

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=1516 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=1515 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.#IND	1.6459	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Data Analysis for Arsenic
The following data points were entered by the user for analysis.

Arsenic (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.08	0.09	0.1	0.1	0.105	0.105	0.11	0.115	0.115	0.12
10	0.14	0.23	0.23	0.26	0.29	0.3	0.33	0.34	0.38	0.41
20	0.44	0.47	0.54	0.54	0.58	0.62	0.7	0.74	0.78	0.8
30	0.81	1	1	1.1	1.2	1.4	1.7	1.7	1.7	2.1
40	2.2									

SUMMARY STATISTICS for Arsenic	
n	41
Min	0.08
Max	2.2
Range	2.12

Mean				0.63585				
Median				0.44				
Variance				0.34069				
StdDev				0.58368				
Std Error				0.091156				
Skewness				1.2458				
Interquartile Range				0.775				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.08	0.091	0.101	0.13	0.44	0.905	1.7	2.06	2.2

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Arsenic			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.68	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8461
Shapiro-Wilk 5% Critical Value	0.94

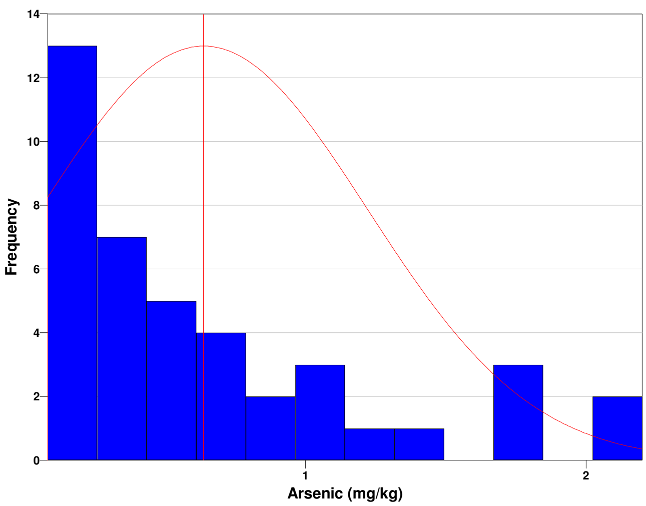
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

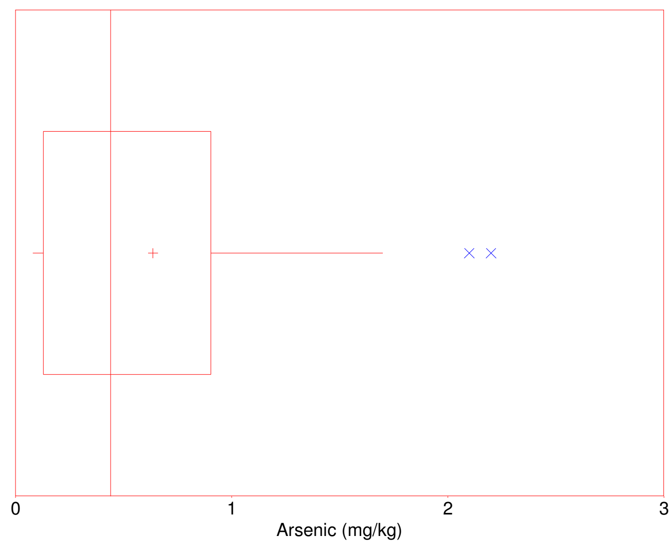
Data Plots for Arsenic
Graphical displays of the data are shown below.

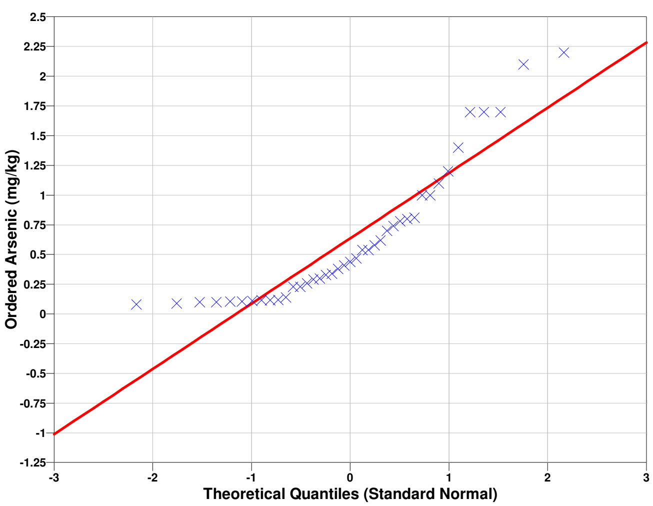
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Arsenic

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST

Shapiro-Wilk Test Statistic	0.8361
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.7893
95% Non-Parametric (Chebyshev) UCL	1.033

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (1.033) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-190.49	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Barium
The following data points were entered by the user for analysis.

Barium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

0	4.2	4.6	5.4	6.7	7.4	7.7	8.5	8.6	9.6	10.2
10	11.4	11.5	11.8	12	12.4	13.5	16.3	21.5	23.1	23.5
20	25	25.1	25.2	26.4	26.5	29.3	31.1	36.2	39.1	39.6
30	41.8	47.2	47.5	50.6	52.4	59.7	66.9	77.7	78.7	97.8
40	98.7									

SUMMARY STATISTICS for Barium								
n	41							
Min	4.2							
Max	98.7							
Range	94.5							
Mean	30.546							
Median	25							
Variance	641.13							
StdDev	25.321							
Std Error	3.9544							
Skewness	1.2462							
Interquartile Range	33.7							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
4.2	4.68	6.84	10.8	25	44.5	75.54	95.89	98.7

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Barium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.692	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8687

Shapiro-Wilk 5% Critical Value	0.94

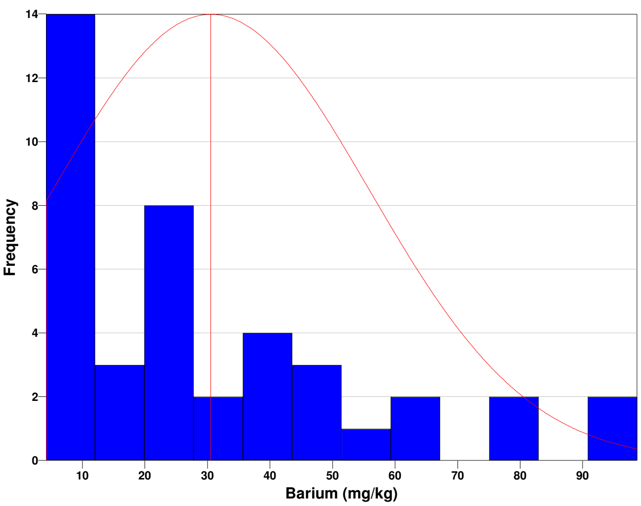
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

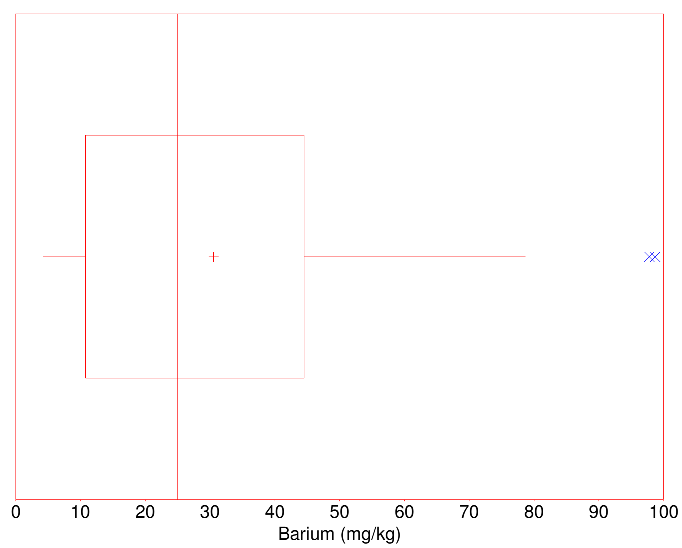
Data Plots for Barium
Graphical displays of the data are shown below.

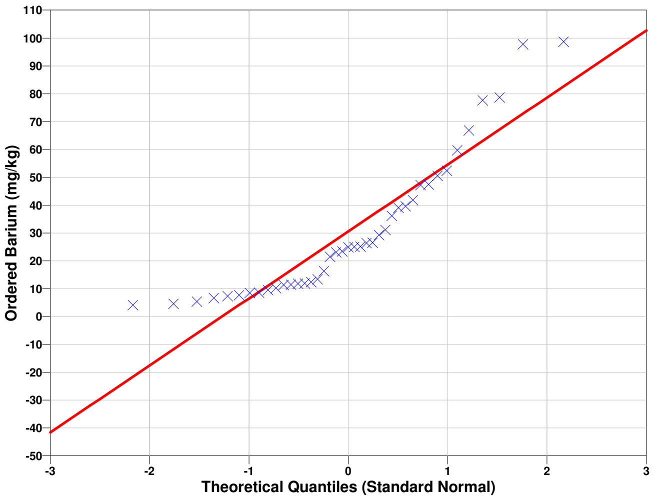
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Barium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8521
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	37.2
95% Non-Parametric (Chebyshev) UCL	47.78

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (47.78) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-75.726	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Beryllium
The following data points were entered by the user for analysis.

Beryllium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.009	0.0115	0.0115	0.012	0.013	0.014	0.023	0.023	0.035	0.035
10	0.041	0.042	0.044	0.0445	0.047	0.054	0.064	0.064	0.067	0.086
20	0.097	0.1	0.1	0.1	0.11	0.11	0.11	0.12	0.13	0.13
30	0.15	0.15	0.19	0.21	0.25	0.27	0.28	0.29	0.3	0.32
40	0.42									

SUMMARY STATISTICS for Beryllium								
n	41							
Min	0.009							
Max	0.42							
Range	0.411							
Mean	0.11409							
Median	0.097							
Variance	0.010478							
StdDev	0.10236							
Std Error	0.015986							
Skewness	1.2312							
Interquartile Range	0.112							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.009	0.0115	0.0122	0.038	0.097	0.15	0.288	0.318	0.42

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Beryllium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.989	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8565
Shapiro-Wilk 5% Critical Value	0.94

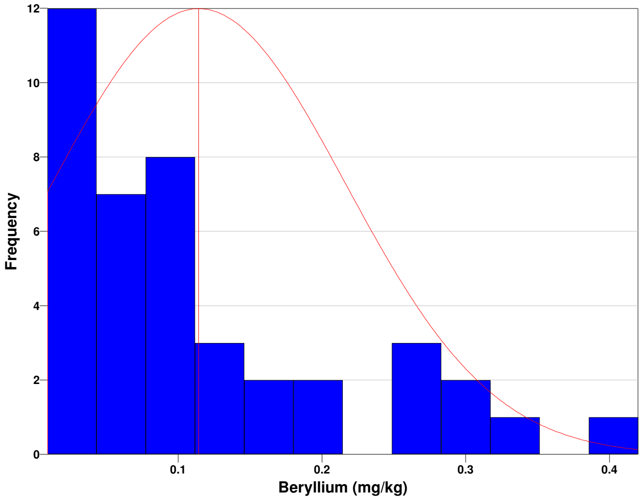
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

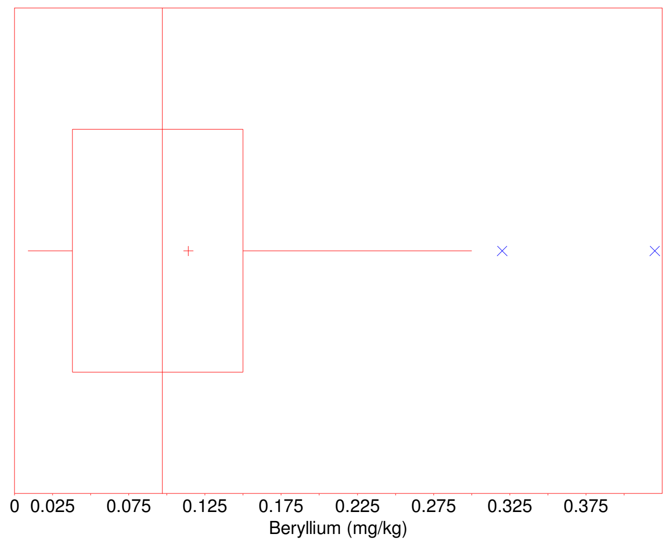
Data Plots for Beryllium
Graphical displays of the data are shown below.

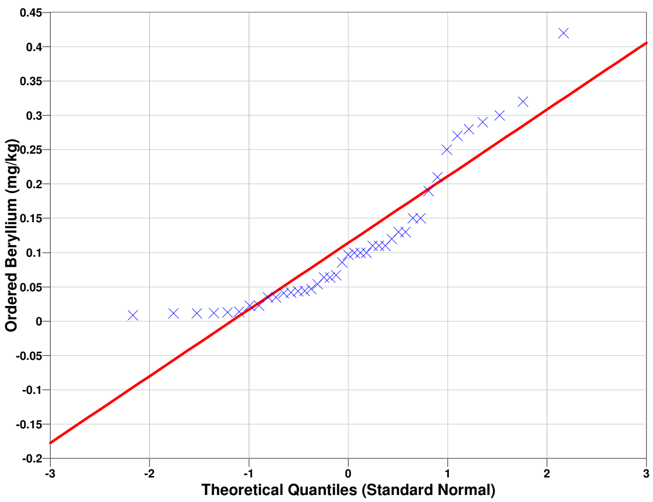
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Beryllium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8553
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.141

95% Non-Parametric (Chebyshev) UCL	0.1838

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.1838) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-618.41	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Chromium
The following data points were entered by the user for analysis.

Chromium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.58	0.59	0.6	0.63	0.76	0.8	0.98	1	1.2	1.2
10	1.4	1.5	1.7	1.8	1.8	1.9	2.1	2.2	2.2	2.3
20	2.4	2.5	2.5	2.7	2.9	3.2	3.2	3.4	3.5	3.7
30	3.7	3.9	4.1	4.3	4.9	5.2	6	6.1	7.4	8.8
40	15									

SUMMARY STATISTICS for Chromium	
n	41
Min	0.58
Max	15

Range	14.42
Mean	3.0888
Median	2.4
Variance	7.2627
StdDev	2.6949
Std Error	0.42088
Skewness	2.5355
Interquartile Range	2.5

Percentiles

1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.58	0.591	0.656	1.3	2.4	3.8	6.08	8.66	15

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Chromium

k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.42	3.05	Yes

The test statistic 4.42 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Chromium	
1	15

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8953
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

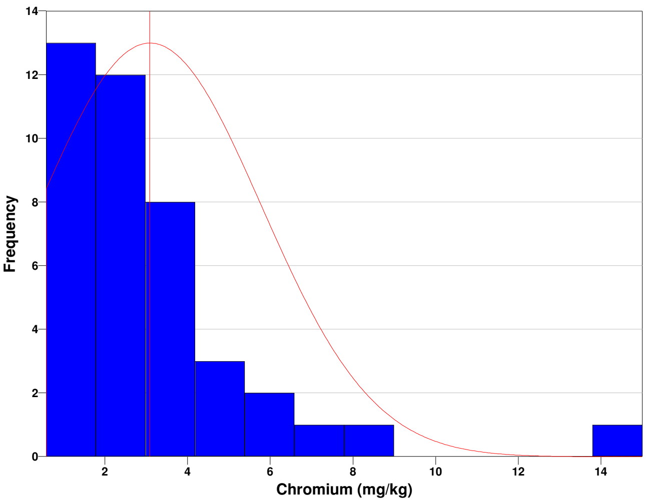
Data Plots for Chromium
Graphical displays of the data are shown below.

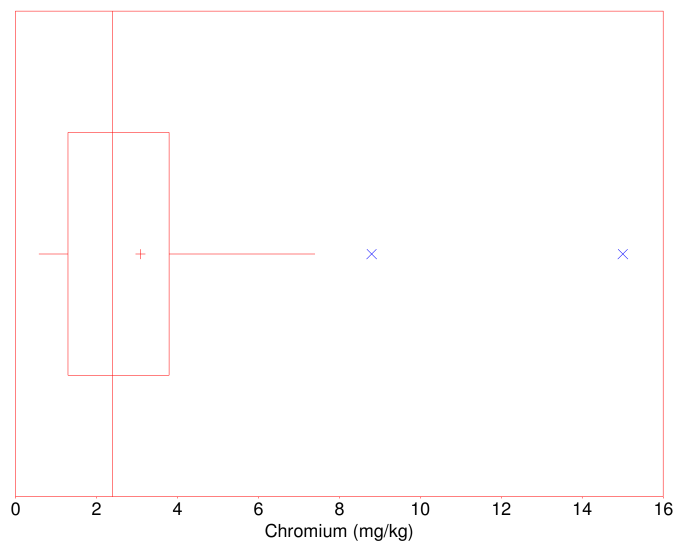
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

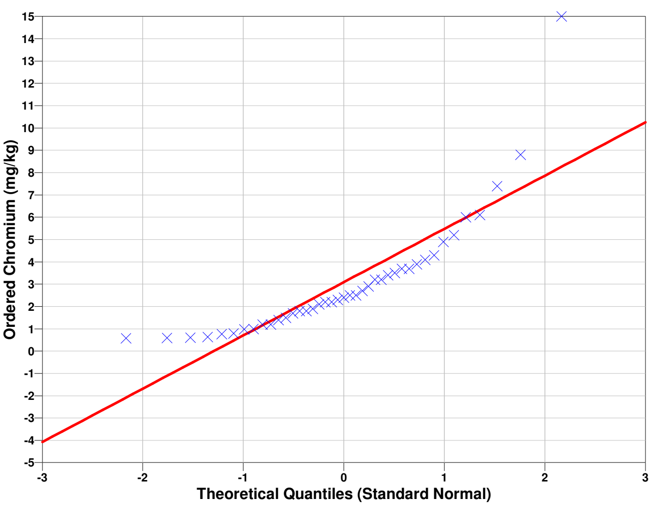
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Chromium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7725
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	3.797
95% Non-Parametric (Chebyshev) UCL	4.923

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (4.923) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
6.3885	1.6839	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
0	26	Cannot Reject
Note: There may not be enough data to reject the null hypothesis (and conclude site is clean) with 95% confidence using the MARSSIM sign test.		

Data Analysis for Cobalt
The following data points were entered by the user for analysis.

Cobalt (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.07	0.08	0.09	0.09	0.095	0.095	0.095	0.1	0.1	0.105
10	0.11	0.125	0.24	0.25	0.26	0.31	0.34	0.35	0.39	0.44
20	0.48	0.5	0.55	0.56	0.56	0.58	0.58	0.61	0.69	0.715
30	0.72	0.73	0.78	0.84	0.99	1.1	1.2	1.5	1.7	1.9
40	1.9									

SUMMARY STATISTICS for Cobalt	
n	41
Min	0.07
Max	1.9
Range	1.83
Mean	0.55902
Median	0.48
Variance	0.24915
StdDev	0.49914
Std Error	0.077953
Skewness	1.3458
Interquartile Range	0.6175

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.07	0.081	0.091	0.1075	0.48	0.725	1.44	1.88	1.9

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Cobalt			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.687	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is

recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8517
Shapiro-Wilk 5% Critical Value	0.94

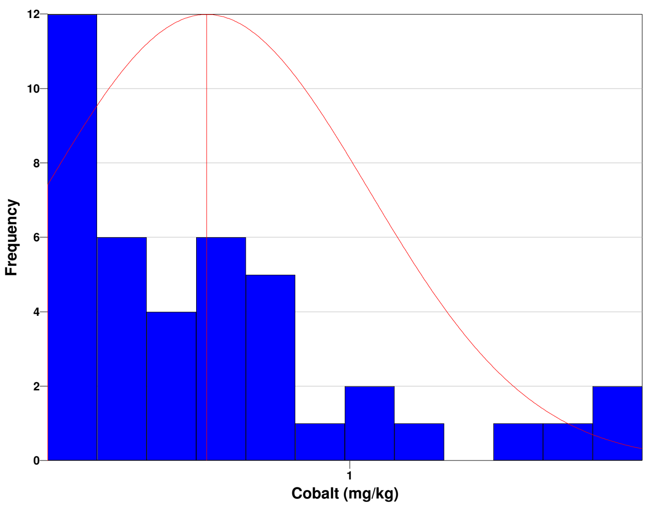
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

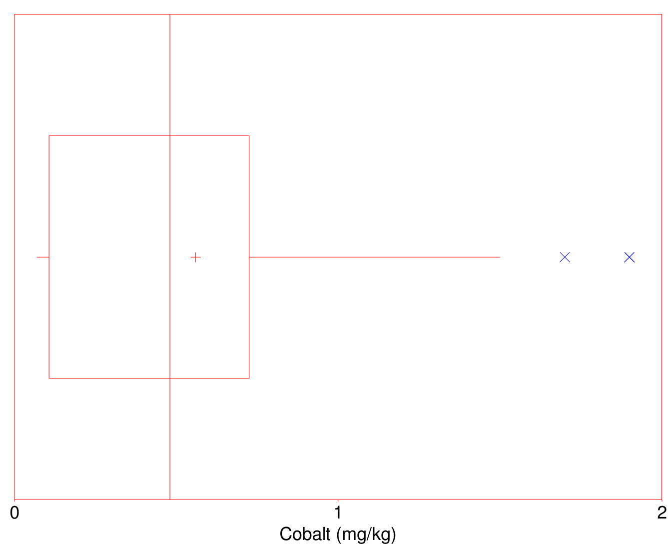
Data Plots for Cobalt
Graphical displays of the data are shown below.

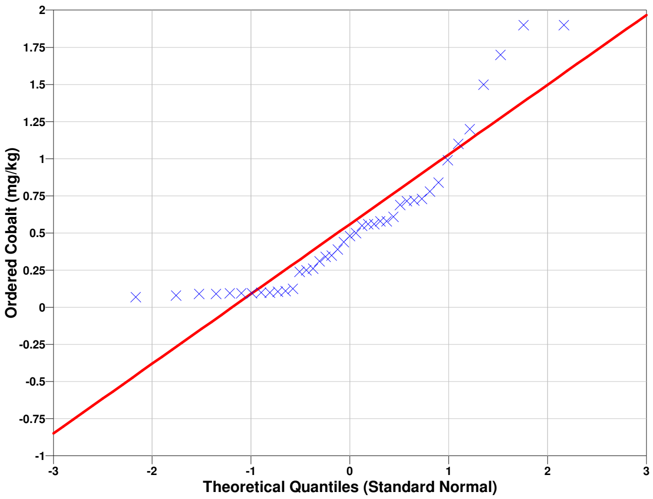
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Cobalt
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.835
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.6903
95% Non-Parametric (Chebyshev) UCL	0.8988

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.8988) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-159.6	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Copper
The following data points were entered by the user for analysis.

Copper (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.35	0.39	0.39	0.44	0.45	0.47	0.48	0.49	0.58	0.59
10	0.61	0.62	0.72	0.725	0.79	0.89	0.9	0.92	0.96	1
20	1.1	1.1	1.2	1.2	1.3	1.3	1.5	1.6	1.7	1.8
30	1.9	1.9	1.9	2	2.1	2.4	3.8	3.9	4.1	4.4
40	5.9									

SUMMARY STATISTICS for Copper								
n	41							
Min	0.35							
Max	5.9							
Range	5.55							
Mean	1.4845							
Median	1.1							
Variance	1.5972							
StdDev	1.2638							
Std Error	0.19737							
Skewness	1.8525							
Interquartile Range	1.3							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.35	0.39	0.442	0.6	1.1	1.9	3.88	4.37	5.9

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Copper			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.494	3.05	Yes

The test statistic 3.494 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Copper	
1	5.9

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8002
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

Data Plots for Copper
Graphical displays of the data are shown below.

The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

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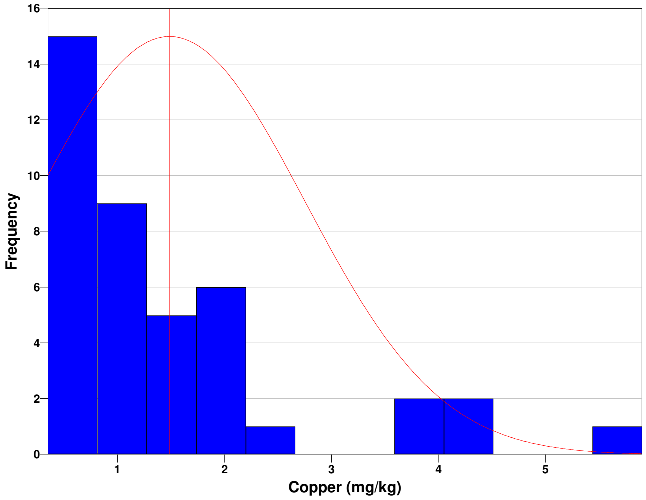
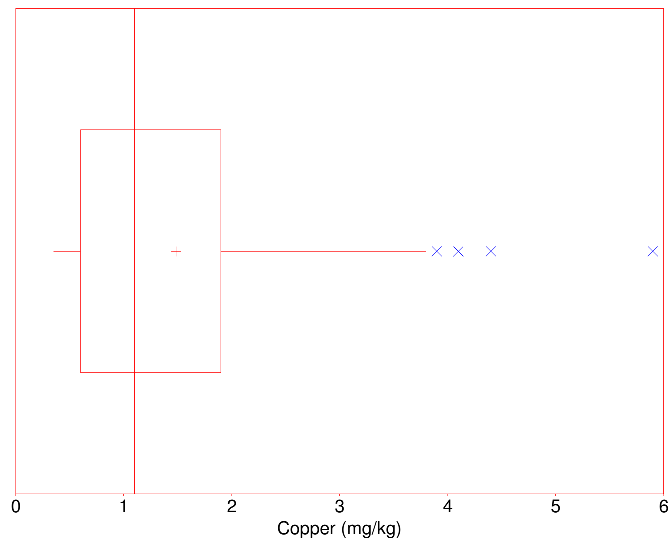
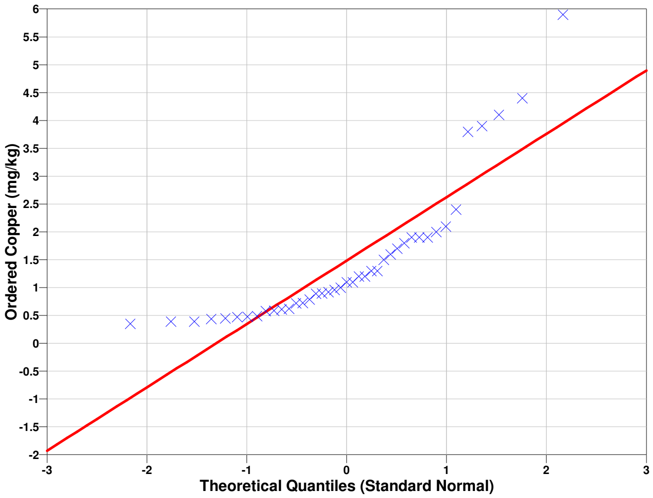
The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the

Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Copper
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7798
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	1.817
95% Non-Parametric (Chebyshev) UCL	2.345

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (2.345) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-301.54	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Diethyl phthalate
The following data points were entered by the user for analysis.

Diethyl phthalate (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.024	0.026	0.026	0.026	0.0265	0.0265	0.0265	0.0265	0.027	0.027
10	0.027	0.027	0.027	0.027	0.027	0.027	0.0275	0.0275	0.0275	0.0275
20	0.0275	0.0275	0.028	0.0285	0.0285	0.0285	0.0285	0.029	0.029	0.0295
30	0.0295	0.0305	0.031	0.0315	0.0763	0.0952	0.101	0.111	0.12	0.123
40	0.31									

SUMMARY STATISTICS for Diethyl phthalate	
n	41

Min				0.024				
Max				0.31				
Range				0.286				
Mean				0.045793				
Median				0.0275				
Variance				0.0025795				
StdDev				0.050789				
Std Error				0.0079319				
Skewness				3.952				
Interquartile Range				0.003				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.024	0.026	0.0261	0.027	0.0275	0.03	0.109	0.1227	0.31

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Diethyl phthalate			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.202	3.05	Yes

The test statistic 5.202 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Diethyl phthalate	
1	0.31

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.4949
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

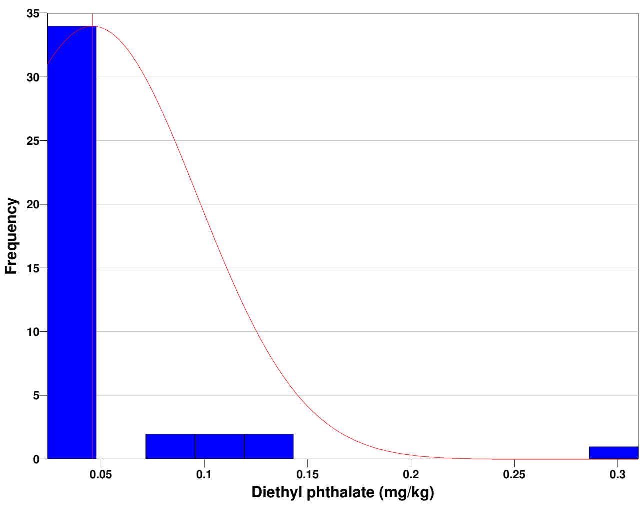
Data Plots for Diethyl phthalate

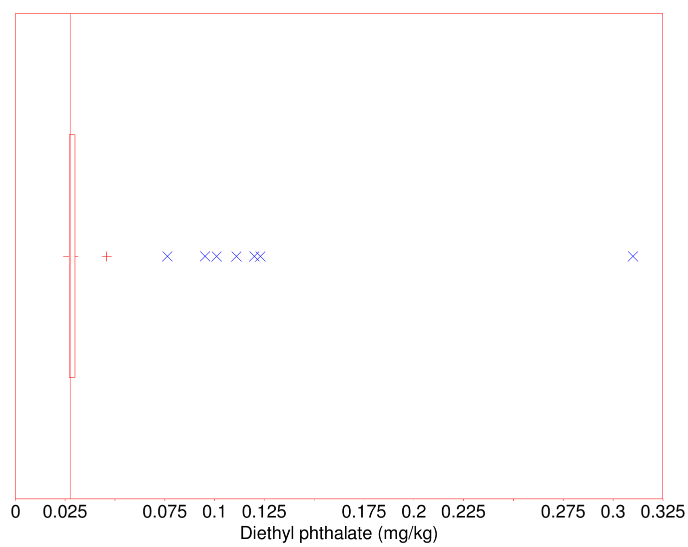
Graphical displays of the data are shown below.

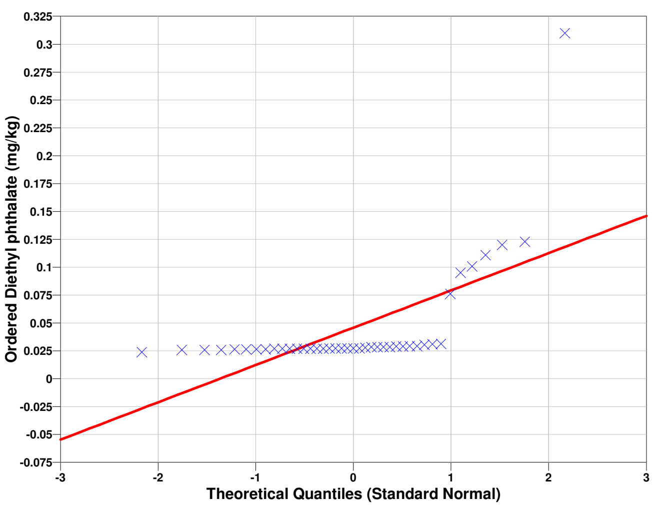
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Diethyl phthalate
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.4472
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.05915
95% Non-Parametric (Chebyshev) UCL	0.08037

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.08037) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-12601	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**

41	26	Reject

Data Analysis for Lead
The following data points were entered by the user for analysis.

Lead (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1.3	1.5	1.5	1.6	1.7	1.7	1.8	1.9	1.9	1.9
10	2	2.1	2.15	2.3	2.3	2.3	2.3	2.4	2.5	2.6
20	2.7	2.7	2.7	2.8	3.1	3.2	3.2	3.5	3.6	3.8
30	4.1	4.2	4.2	4.3	5.7	5.9	6	6.3	6.8	9.3
40	26									

SUMMARY STATISTICS for Lead	
n	41
Min	1.3
Max	26
Range	24.7
Mean	3.7524
Median	2.7
Variance	15.65
StdDev	3.956
Std Error	0.61782
Skewness	4.7237
Interquartile Range	2.2

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
1.3	1.5	1.62	1.95	2.7	4.15	6.24	9.05	26

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Lead			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.624	3.05	Yes

The test statistic 5.624 exceeded the corresponding critical value, therefore that test is significant and we conclude that the

most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Lead	
1	26

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.835
Shapiro-Wilk 5% Critical Value	0.94

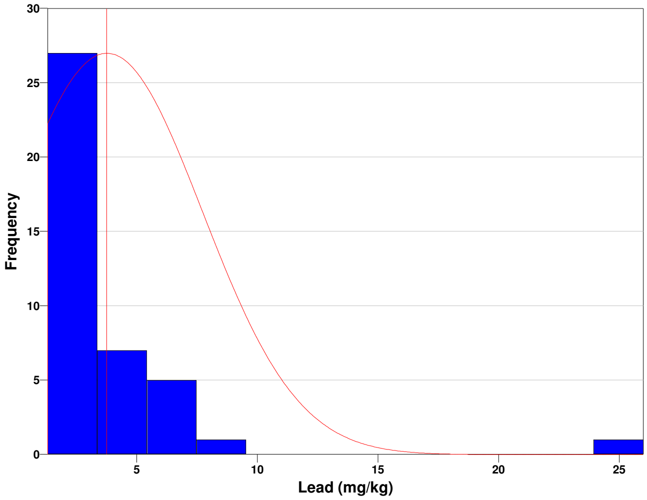
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

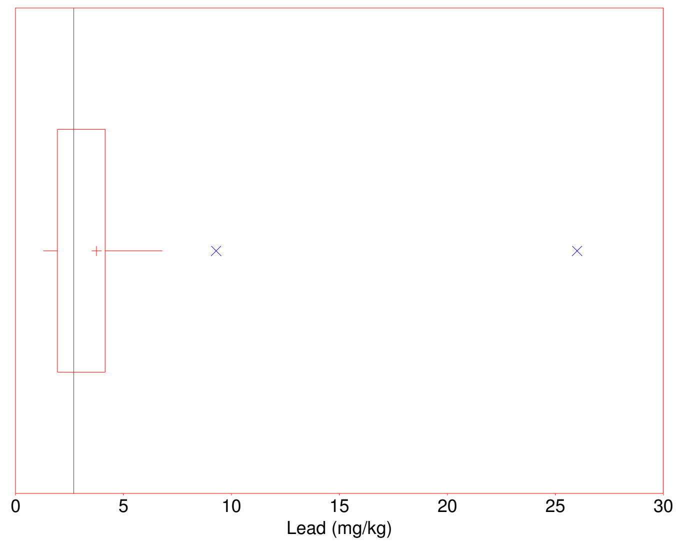
Data Plots for Lead
Graphical displays of the data are shown below.

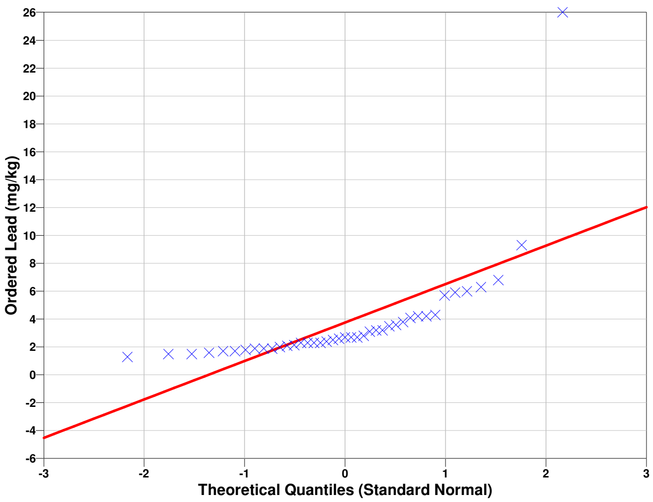
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Lead

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5047
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	4.793

95% Non-Parametric (Chebyshev) UCL	6.445

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (6.445) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-188.16	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Manganese
The following data points were entered by the user for analysis.

Manganese (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	2.7	3.1	3.5	4.1	4.4	4.5	4.6	5.1	5.5	6.2
10	7.5	9	9.1	9.9	9.9	10.1	10.8	11.9	12.9	13.9
20	17.2	17.8	19.7	21.3	29	31.7	36	49.3	51.3	54.3
30	69.5	70.1	73	75	76.3	112	130	134	146	153
40	241									

SUMMARY STATISTICS for Manganese	
n	41
Min	2.7
Max	241

Range				238.3				
Mean				42.834				
Median				17.2				
Variance				2886.1				
StdDev				53.723				
Std Error				8.3901				
Skewness				1.8878				
Interquartile Range				62.95				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
2.7	3.14	4.16	6.85	17.2	69.8	133.2	152.3	241

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Manganese			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.689	3.05	Yes

The test statistic 3.689 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Manganese	
1	241

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7607
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

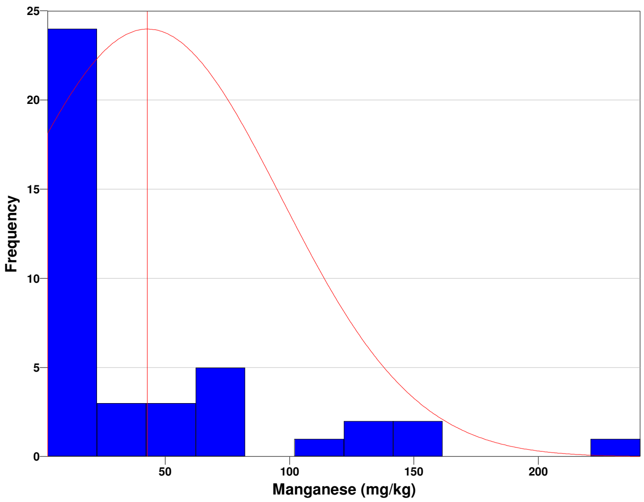
Data Plots for Manganese
Graphical displays of the data are shown below.

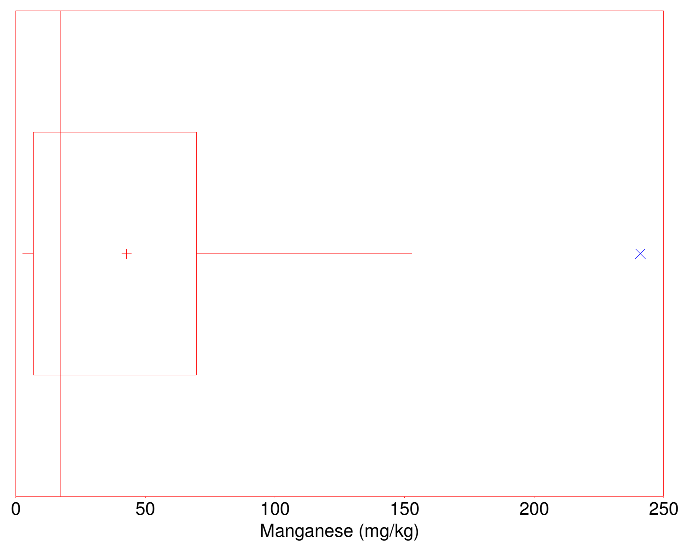
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

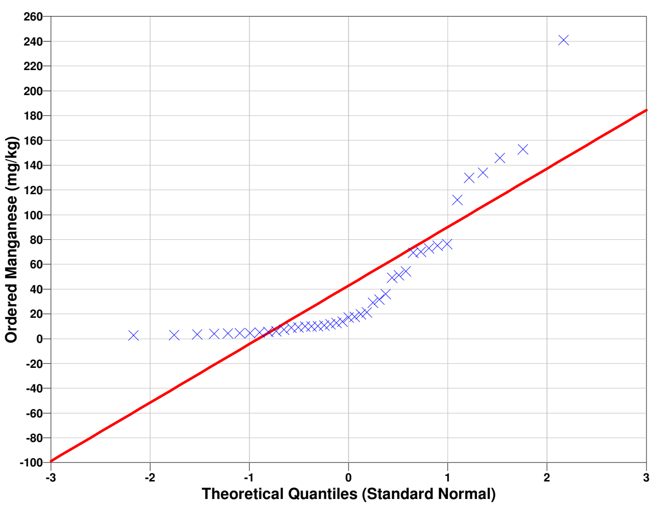
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Manganese
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7451
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	56.96
95% Non-Parametric (Chebyshev) UCL	79.41

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (79.41) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-54.489	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Mercury
The following data points were entered by the user for analysis.

Mercury (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00035	0.00036	0.000365	0.00038	0.00038	0.00038	0.000385	0.00043	0.00044	0.0013
10	0.0017	0.0021	0.0024	0.0025	0.0026	0.0038	0.0043	0.0045	0.0046	0.0048
20	0.0048	0.0051	0.0053	0.0065	0.0072	0.0073	0.0077	0.008	0.01	0.011
30	0.012	0.012	0.013	0.014	0.019	0.033	0.048	0.054	0.055	0.055
40	0.59									

SUMMARY STATISTICS for Mercury								
n	41							
Min	0.00035							
Max	0.59							
Range	0.58965							
Mean	0.02478							
Median	0.0048							
Variance	0.0084248							
StdDev	0.091787							
Std Error	0.014335							
Skewness	6.13							
Interquartile Range	0.0105							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00035	0.0003605	0.00038	0.0015	0.0048	0.012	0.0528	0.055	0.59

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Mercury			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	6.158	3.05	Yes

The test statistic 6.158 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Mercury

1	0.59

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6364
Shapiro-Wilk 5% Critical Value	0.94

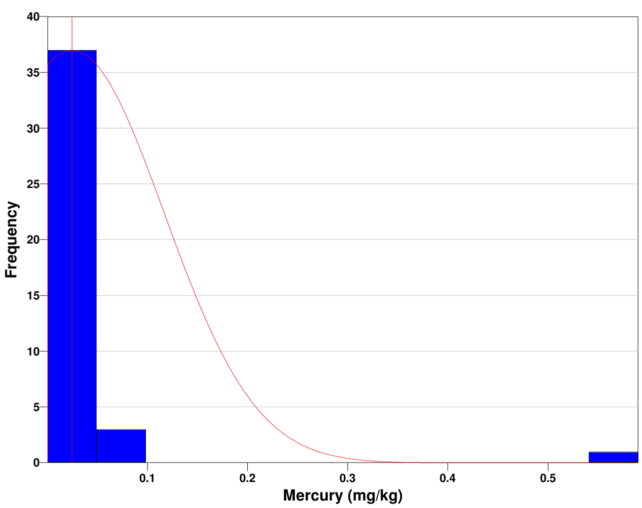
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

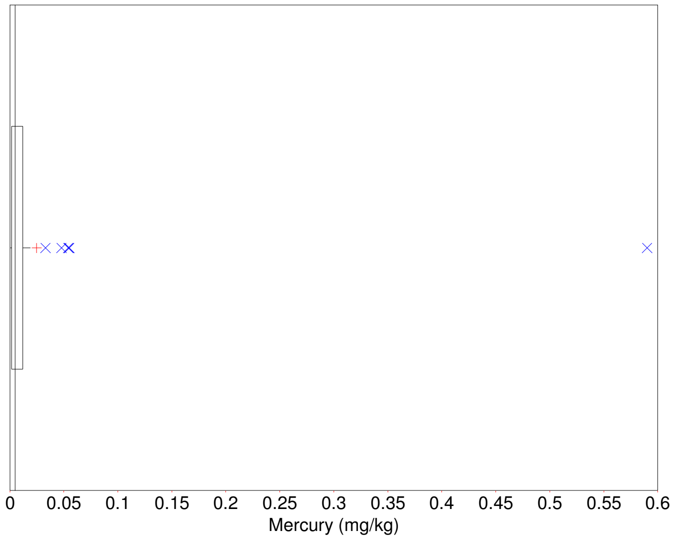
Data Plots for Mercury
Graphical displays of the data are shown below.

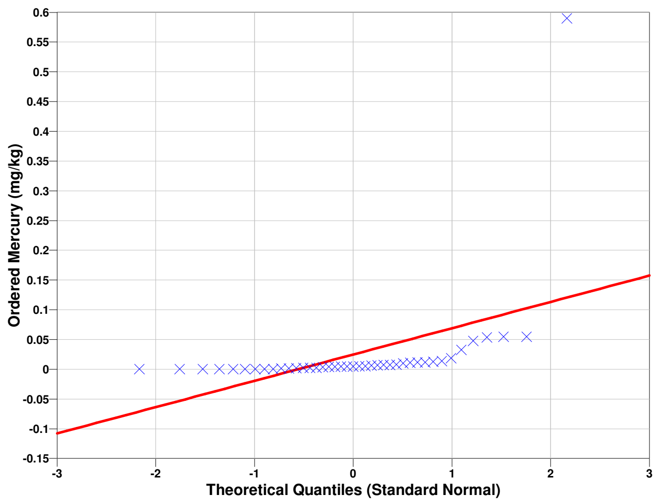
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Mercury
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.2612
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.04892

95% Non-Parametric (Chebyshev) UCL	0.08726

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.08726) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-5.2474	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
40	26	Reject

Data Analysis for Nickel
The following data points were entered by the user for analysis.

Nickel (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.06	0.065	0.08	0.18	0.21	0.22	0.22	0.23	0.26	0.26
10	0.28	0.29	0.32	0.36	0.36	0.39	0.46	0.66	0.73	0.99
20	1	1.1	1.3	1.3	1.4	1.4	1.4	1.5	1.5	1.8
30	1.8	1.8	1.8	1.8	2.4	2.6	2.9	3.6	4	5.8
40	5.9									

SUMMARY STATISTICS for Nickel	
n	41
Min	0.06
Max	5.9

Range				5.84				
Mean				1.3348				
Median				1				
Variance				2.0169				
StdDev				1.4202				
Std Error				0.2218				
Skewness				1.8288				
Interquartile Range				1.53				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.06	0.0665	0.186	0.27	1	1.8	3.46	5.62	5.9

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Nickel			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.215	3.05	Yes

The test statistic 3.215 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Nickel	
1	5.9

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8158
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

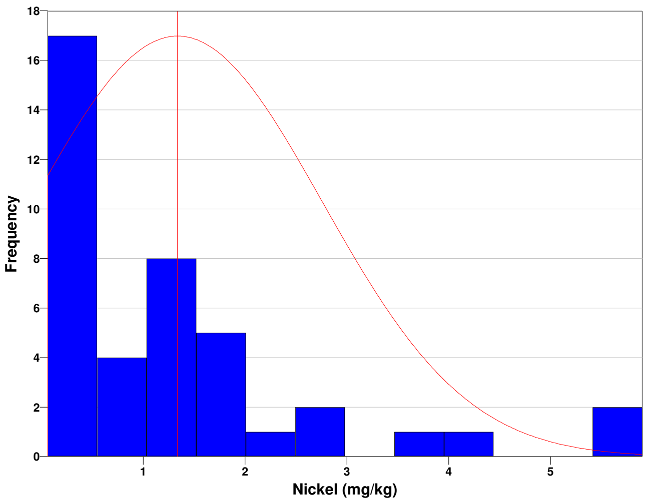
Data Plots for Nickel
Graphical displays of the data are shown below.

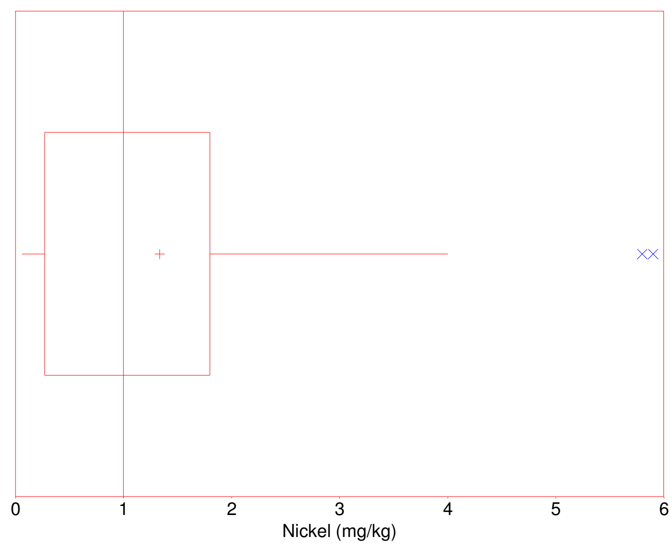
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

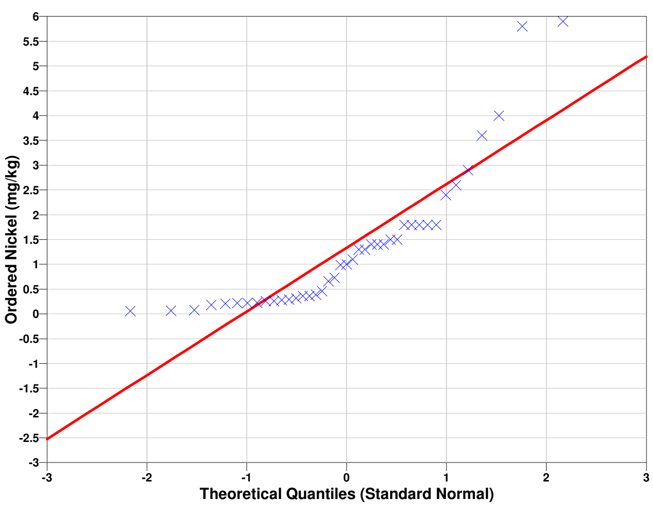
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Nickel
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.784
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	1.708
95% Non-Parametric (Chebyshev) UCL	2.302

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (2.302) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-129.24	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

Data Analysis for Vanadium
The following data points were entered by the user for analysis.

Vanadium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.65	0.77	0.83	0.89	0.95	0.97	1	1.1	1.2	1.3
10	1.7	1.7	1.8	1.95	2	2.1	2.3	2.4	2.4	2.4
20	2.9	3.1	3.2	3.6	3.7	3.8	4.3	4.4	4.5	5
30	5.3	5.7	5.8	6	6.7	6.9	7.1	11	12.1	13
40	13.7									

SUMMARY STATISTICS for Vanadium	
n	41
Min	0.65
Max	13.7
Range	13.05
Mean	3.9563
Median	2.9
Variance	11.535
StdDev	3.3963
Std Error	0.53042
Skewness	1.5509
Interquartile Range	4

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.65	0.776	0.902	1.5	2.9	5.5	10.22	12.91	13.7

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Vanadium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.869	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the

suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8286
Shapiro-Wilk 5% Critical Value	0.94

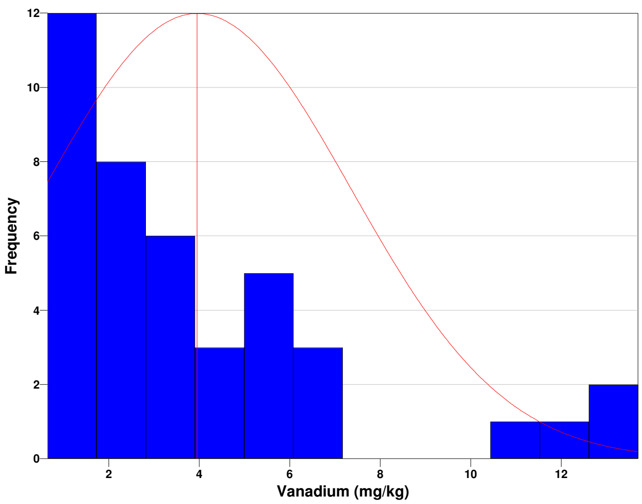
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

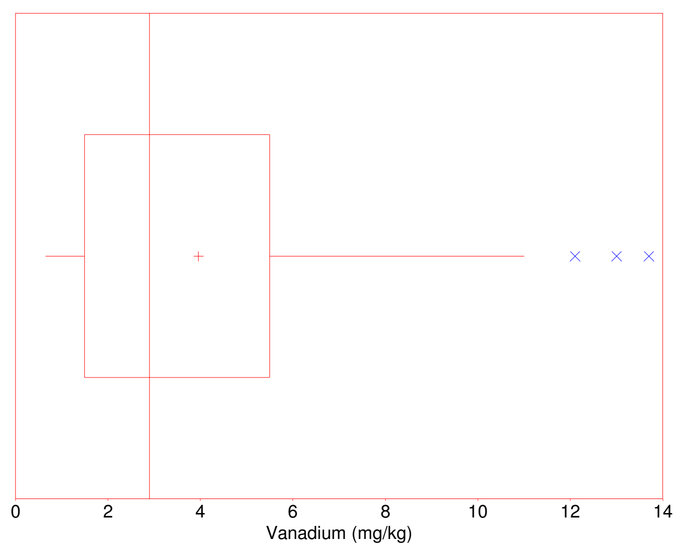
Data Plots for Vanadium
Graphical displays of the data are shown below.

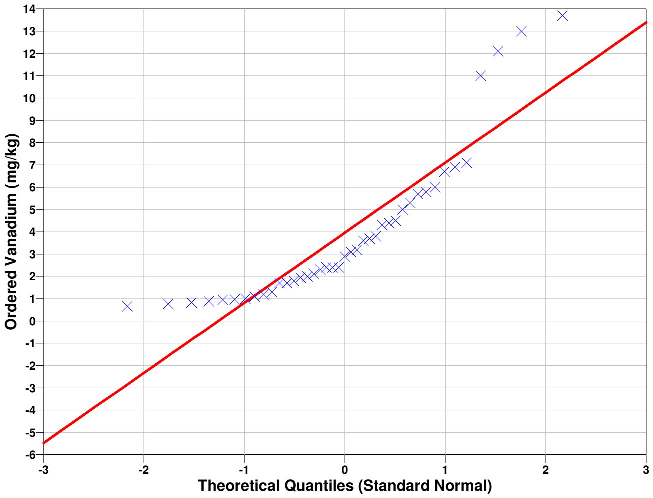
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Vanadium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8131
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	4.849
95% Non-Parametric (Chebyshev) UCL	6.268

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (6.268) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test

A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where

x is the sample mean of the n=41 data,

AL is the action level or threshold (120),

SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
3.6883	1.6839	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
14	25	Cannot Reject
Note: There may not be enough data to reject the null hypothesis (and conclude site is clean) with 95% confidence using the MARSSIM sign test.		

Data Analysis for Zinc
The following data points were entered by the user for analysis.

Zinc (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1.5	1.5	1.6	1.6	2.1	2.2	2.3	2.3	2.8	2.8
10	2.9	3.1	3.1	3.2	3.6	4.4	4.4	5.4	5.7	6.4
20	6.5	6.7	7	7	7.1	7.2	7.3	7.3	7.4	8.1
30	8.3	10.3	10.3	11	11	15	16.6	18.9	19.5	23.6
40	24.8									

SUMMARY STATISTICS for Zinc	
n	41
Min	1.5
Max	24.8
Range	23.3
Mean	7.4098
Median	6.5
Variance	35.841
StdDev	5.9867
Std Error	0.93497
Skewness	1.486
Interquartile Range	6.45

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**

1.5	1.51	1.7	2.85	6.5	9.3	18.44	23.19	24.8

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Zinc			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	2.905	3.05	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8409
Shapiro-Wilk 5% Critical Value	0.94

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

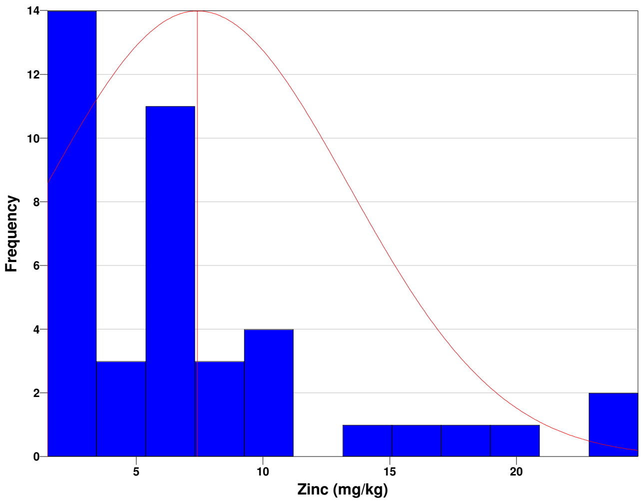
Data Plots for Zinc
Graphical displays of the data are shown below.

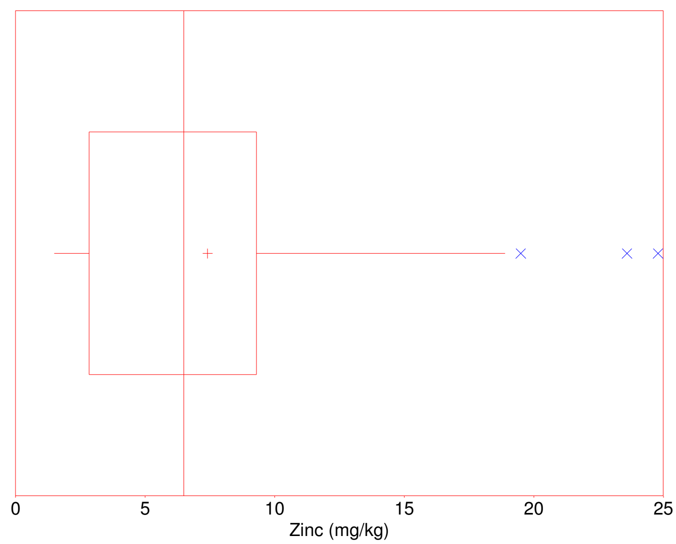
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

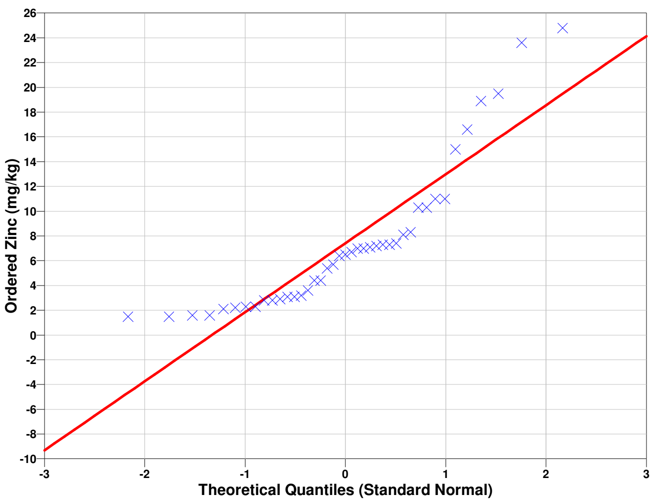
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a

fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Zinc

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.823
Shapiro-Wilk 5% Critical Value	0.941

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN

95% Parametric UCL	8.984
95% Non-Parametric (Chebyshev) UCL	11.49

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (11.49) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=41 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=40 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-120.42	1.6839	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
41	26	Reject

This report was automatically produced* by Visual Sample Plan (VSP) software version 5.3.1.
Software and documentation available at http://dqo.pnl.gov/vsp

* - The report contents may have been modified or reformatted by end-user of software.

Appendix C

VSP Reports of Calculated Minimum Sample Quantity
Report 9
Area of Concern – 1
Minimum Sample Quantity Calculation for Groundwater using Human Health Benchmarks and Delta Method 1

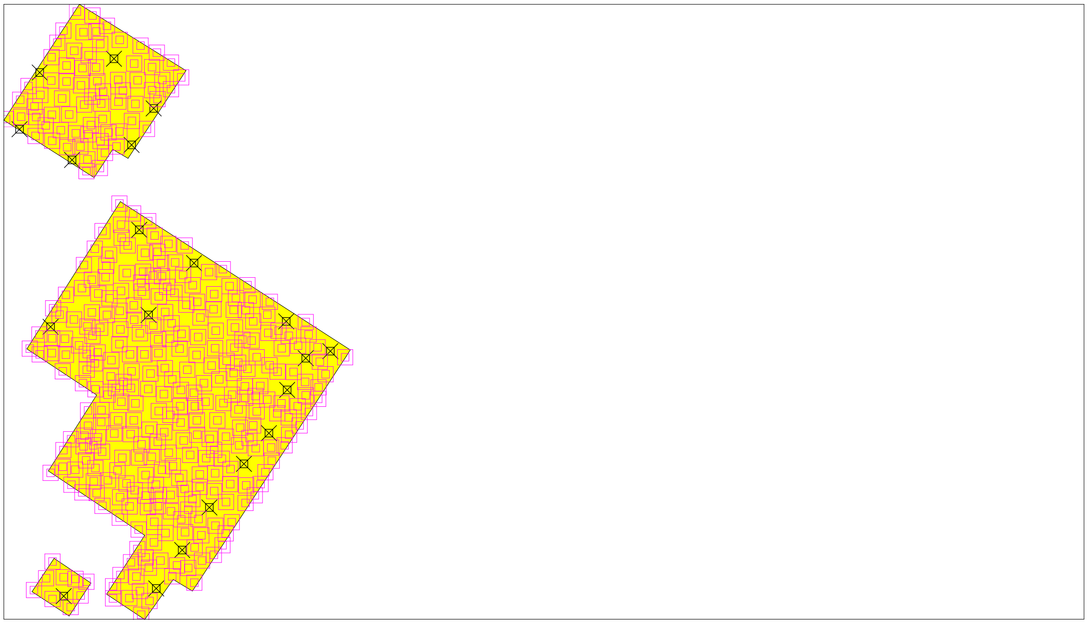
Random sampling locations for comparing a mean with a fixed threshold (parametric)

Summary
This report summarizes the sampling design, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design for Arsenic, the driving analyte (the analyte which required the largest number of samples). A figure that shows sampling locations in the field is also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean to a fixed threshold
Type of Sampling Design	Parametric
Sample Placement (Location) in the Field	Simple random sampling
Working (Null) Hypothesis	The mean value at the site exceeds the threshold
Formula for calculating number of sampling locations	Student's t-test
Calculated total number of samples	377
Number of samples on map [a]	377
Number of selected sample areas [b]	1
Specified sampling area [c]	188054.34 m^2
Total cost of sampling [d]	$189,500.00

[a] This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[d] Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.



Primary Sampling Objective
The primary purpose of sampling at this site is to compare a mean value of a site with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the mean value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the mean value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative hypothesis, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach
A parametric random sampling approach was used to determine the number of samples and to specify sampling locations. A parametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that parametric assumptions are reasonable. These assumptions will be examined in post-sampling data analysis.

Both parametric and non-parametric approaches rely on assumptions about the population. However, non-parametric approaches typically require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than the number of samples required by non-parametric approaches.

Locating the sample points randomly provides data that are separated by many distances, whereas systematic samples are all equidistant apart. Therefore, random sampling provides more information about the spatial structure of the potential contamination than systematic sampling does. As with systematic sampling, random sampling also provides information regarding the mean value, but there is the possibility that areas of the site will not be represented with the same frequency as if uniform grid sampling were performed.

Number of Total Samples: Calculation Equation and Inputs
The equation used to calculate the number of samples is based on a Student's t-test. For this site, the null hypothesis is rejected in favor of the alternative hypothesis if the sample mean is sufficiently smaller than the threshold. The number of samples to collect is calculated so that 1) there will be a high probability ($1-\beta$) of rejecting the null hypothesis if the alternative hypothesis is true and 2) a low probability (α) of rejecting the null hypothesis if the null hypothesis is true.

The formula used to calculate the number of samples is:

$$n = \frac{S^2}{\Delta^2}\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2 + 0.5Z_{1-\alpha}^2$$

where
n is the number of samples,
S is the estimated standard deviation of the measured values including analytical error,
Δ is the width of the gray region,
α is the acceptable probability of incorrectly concluding the site mean is less than the threshold,
β is the acceptable probability of incorrectly concluding the site mean exceeds the threshold,
$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is $1-\alpha$,
$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is $1-\beta$.

The values of these inputs that result in the calculated number of sampling locations are:

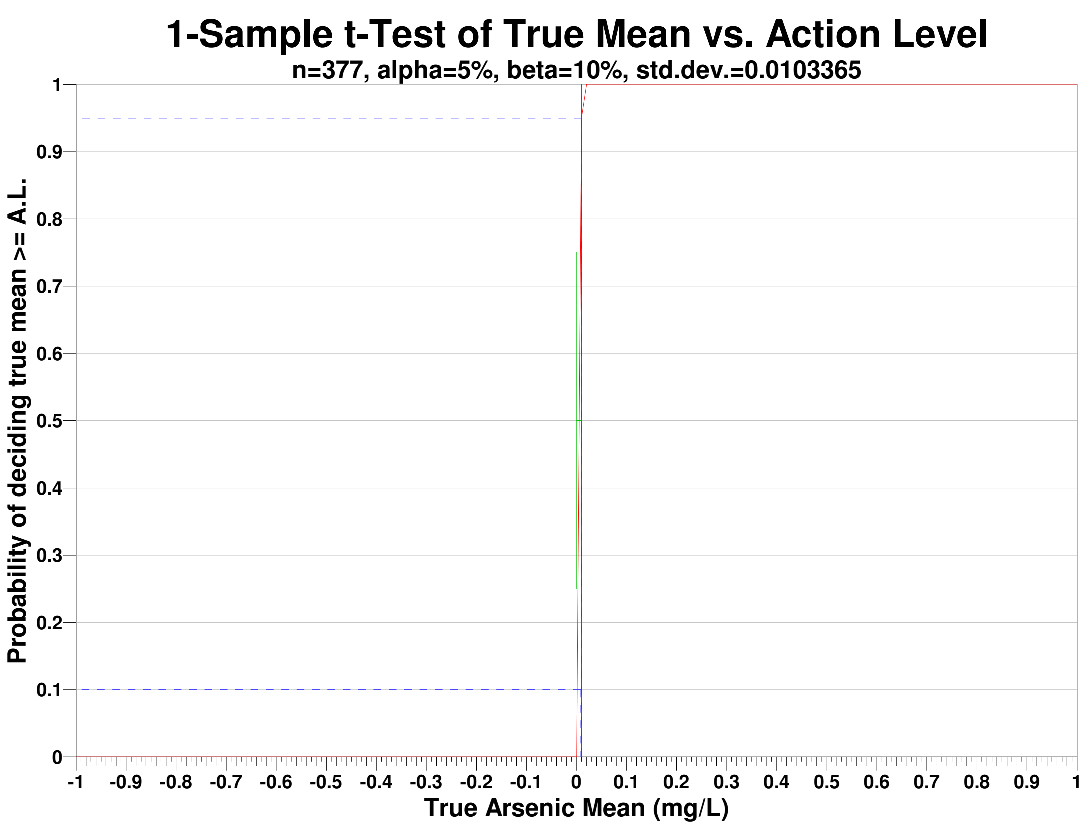
Analyte	**n**	**Parameter**					
		S	**Δ**	**α**	**β**	**$Z_{1-\alpha}$** [a]	**$Z_{1-\beta}$** [b]
00_New_Sample	2	0.1 mg/L	10 mg/L	0.05	0.1	1.64485	1.28155
Acetone	2	0.00226616 mg/L	5.47006 mg/L	0.05	0.1	1.64485	1.28155
Aluminum	4	0.976173 mg/L	1.94099 mg/L	0.05	0.1	1.64485	1.28155
Arsenic	377	0.0103365 mg/L	0.0015625 mg/L	0.05	0.1	1.64485	1.28155
Barium	2	0.139721 mg/L	1.81753 mg/L	0.05	0.1	1.64485	1.28155
Benzene	8	0.00321632 mg/L	0.00387725 mg/L	0.05	0.1	1.64485	1.28155
bis(2-Ethylhexyl)phthalate	3	0.00135615 mg/L	0.0035335 mg/L	0.05	0.1	1.64485	1.28155

Cyclohexane	2	0.00715044 mg/L	12.5124 mg/L	0.05	0.1	1.64485	1.28155
Ethylbenzene	2	0.00195502 mg/L	0.698939 mg/L	0.05	0.1	1.64485	1.28155
Lead	3	0.0046173 mg/L	0.011245 mg/L	0.05	0.1	1.64485	1.28155
Manganese	77	0.984455 mg/L	0.332622 mg/L	0.05	0.1	1.64485	1.28155
Naphthalene	375	0.0364619 mg/L	0.00552456 mg/L	0.05	0.1	1.64485	1.28155
Nickel	2	0.0111778 mg/L	0.483637 mg/L	0.05	0.1	1.64485	1.28155
Thallium	16	0.00181263 mg/L	0.00140875 mg/L	0.05	0.1	1.64485	1.28155
Vanadium	2	0.00434736 mg/L	0.168388 mg/L	0.05	0.1	1.64485	1.28155
Zinc	2	0.0415115 mg/L	7.3006 mg/L	0.05	0.1	1.64485	1.28155
1-Methylnaphthalene	2	0.0144932 mg/L	1.7056 mg/L	0.05	0.1	1.64485	1.28155

[a] This value is automatically calculated by VSP based upon the user defined value of α.
[b] This value is automatically calculated by VSP based upon the user defined value of β.

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000) for Arsenic, the driving analyte. It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true mean values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at 1-α on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at 1-α. If any of the inputs change, the number of samples that result in the correct curve changes.



Statistical Assumptions

The assumptions associated with the formulas for computing the number of samples are:

1. the sample mean is normally distributed (this happens if the data are roughly symmetric or the sample size is more than 30; for extremely skewed data sets, additional samples may be required for the sample mean to be normally distributed),
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected randomly.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the sample locations were selected using a random process.

Sensitivity Analysis

The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that μ > action level and alpha (%), probability of mistakenly concluding that μ < action level. The following table shows the results of this analysis.

Number of Samples								
AL=0		**α=5**		**α=10**		**α=15**		
		s=0.2	**s=0.1**	**s=0.2**	**s=0.1**	**s=0.2**	**s=0.1**	
LBGR=90	**β=5**	432889	108224	342555	85640	287573	71894	
	β=10	342556	85640	262781	65696	214923	53732	
	β=15	287574	71895	214923	53732	171872	42969	
LBGR=80	**β=5**	108224	27057	85640	21411	71894	17974	
	β=10	85640	21411	65696	16425	53732	13434	
	β=15	71895	17975	53732	13434	42969	10743	
LBGR=70	**β=5**	48100	12026	38063	9517	31953	7989	
	β=10	38063	9517	29199	7301	23881	5971	
	β=15	31954	7990	23882	5971	19098	4775	

s = Standard Deviation
LBGR = Lower Bound of Gray Region (% of Action Level)
β = Beta (%), Probability of mistakenly concluding that μ > action level
α = Alpha (%), Probability of mistakenly concluding that μ < action level
AL = Action Level (Threshold)

Cost of Sampling

The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that are based on the number of samples collected and measured. Based on the numbers of samples determined above, the estimated total cost of sampling and analysis at this site is \$189,500.00, which averages out to a per sample cost of \$502.65. The following table summarizes the inputs and resulting cost estimates.

COST INFORMATION			
Cost Details	**Per Analysis**	**Per Sample**	**377 Samples**
Field collection costs		\$100.00	\$37,700.00
Analytical costs	\$400.00	\$400.00	\$150,800.00
Sum of Field & Analytical costs		**\$500.00**	**\$188,500.00**
Fixed planning and validation costs			\$1,000.00
Total cost			**\$189,500.00**

Data Analysis for 00_New_Sample

SUMMARY STATISTICS for 00_New_Sample

n				1165				
Min				0				
Max				0				
Range				0				
Mean				0				
Median				0				
Variance				0				
StdDev				0				
Std Error				0				
Skewness				-1.#IND				
Interquartile Range				0				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0	0	0	0	0	0	0	0	0

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for 00_New_Sample			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	-1.#IO	4.062	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Lilliefors test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Lilliefors Test Statistic	0
Lilliefors 5% Critical Value	0.02597

The calculated Lilliefors test statistic is less than the 5% Lilliefors critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do appear to follow a normal distribution at the 5% level of significance.

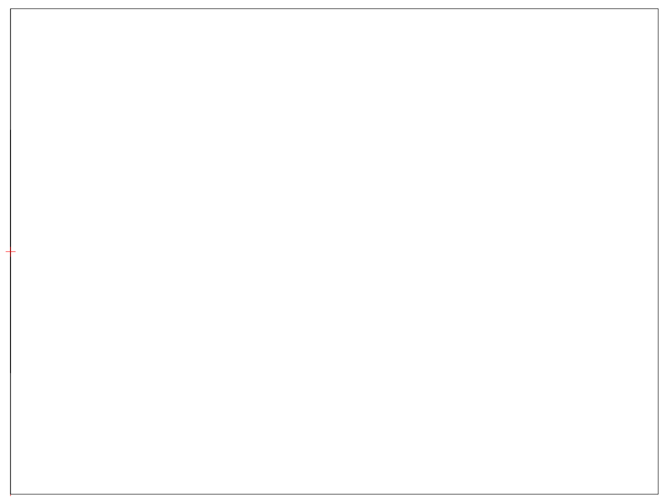
Data Plots for 00_New_Sample
Graphical displays of the data are shown below.

The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The

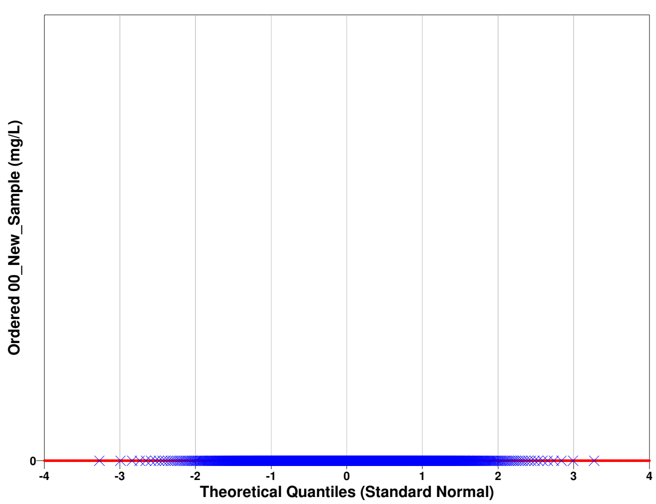
sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.



00_New_Sample (mg/L)



For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for 00_New_Sample
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution.

The Lilliefors test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Lilliefors Test Statistic	0
Lilliefors 5% Critical Value	0.02596

The calculated Lilliefors test statistic is less than the 5% Lilliefors critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0
95% Non-Parametric (Chebyshev) UCL	0

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=1165 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=1164 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.#IND	1.6462	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Data Analysis for Acetone
The following data points were entered by the user for analysis.

Acetone (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0013	0.0013	0.0014	0.00335	0.0036	0.0039	0.004	0.0041	0.00425	0.0047
10	0.005	0.0052	0.0055	0.0057	0.0057	0.0068	0.0073	0.0082	0.0087	0.0089

SUMMARY STATISTICS for Acetone

n	20
Min	0.0013
Max	0.0089
Range	0.0076
Mean	0.004945
Median	0.00485
Variance	5.1355e-006
StdDev	0.0022662
Std Error	0.00050673
Skewness	0.095243
Interquartile Range	0.00285

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0013	0.0013	0.00131	0.003675	0.00485	0.006525	0.00865	0.00889	0.0089

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Acetone	
Dixon Test Statistic	0.014493
Dixon 5% Critical Value	0.45

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.0013 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9583
Shapiro-Wilk 5% Critical Value	0.901

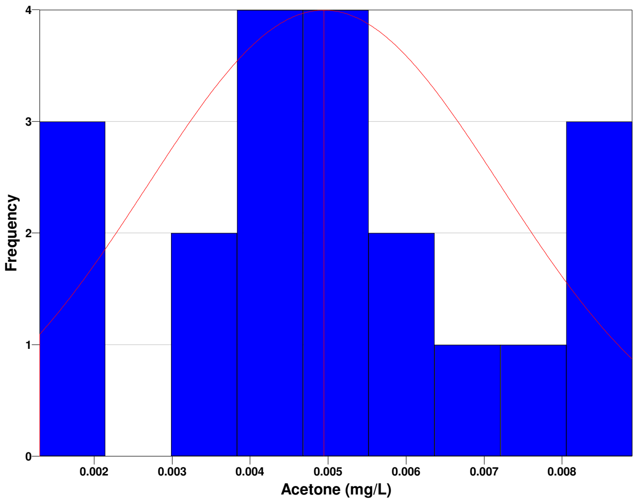
The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.0013, do appear to follow a normal distribution at the 5% level of significance.

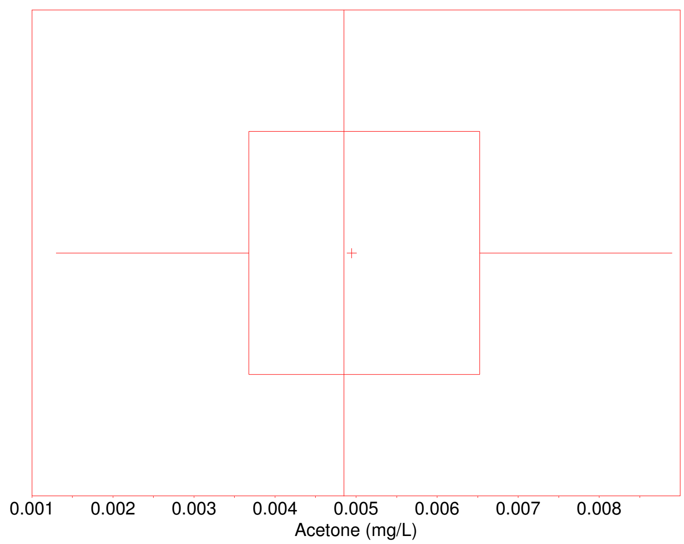
Data Plots for Acetone
Graphical displays of the data are shown below.

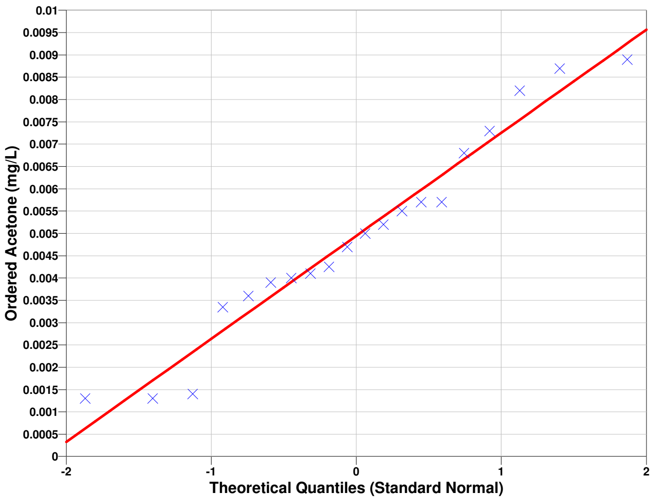
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Acetone
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST

Shapiro-Wilk Test Statistic	0.9519
Shapiro-Wilk 5% Critical Value	0.905

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.005821
95% Non-Parametric (Chebyshev) UCL	0.007154

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0.005821) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=20 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=19 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-10795	1.7291	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Aluminum
The following data points were entered by the user for analysis.

Aluminum (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.0911
10	0.113	0.113	0.354	0.372	0.558	0.68	0.709	0.777	1.63	4.28

SUMMARY STATISTICS for Aluminum	
n	20
Min	0.043

Max				4.28				
Range				4.237				
Mean				0.50321				
Median				0.10205				
Variance				0.95291				
StdDev				0.97617				
Std Error				0.21828				
Skewness				3.4116				
Interquartile Range				0.6065				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.043	0.043	0.043	0.043	0.1021	0.6495	1.545	4.147	4.28

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Aluminum	
Dixon Test Statistic	0
Dixon 5% Critical Value	0.45

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.043 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5358
Shapiro-Wilk 5% Critical Value	0.901

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.043, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

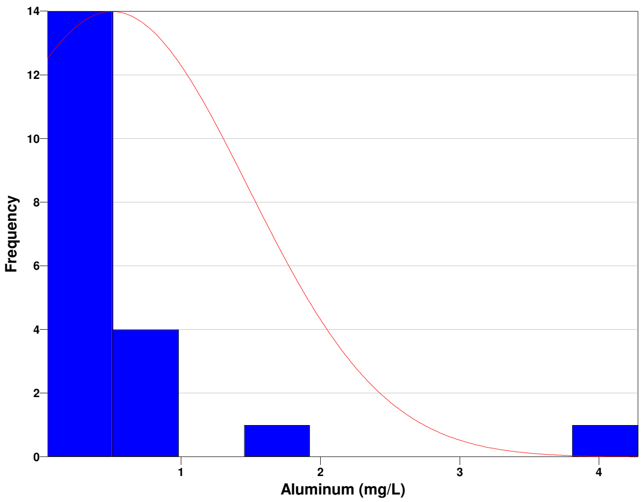
Data Plots for Aluminum
Graphical displays of the data are shown below.

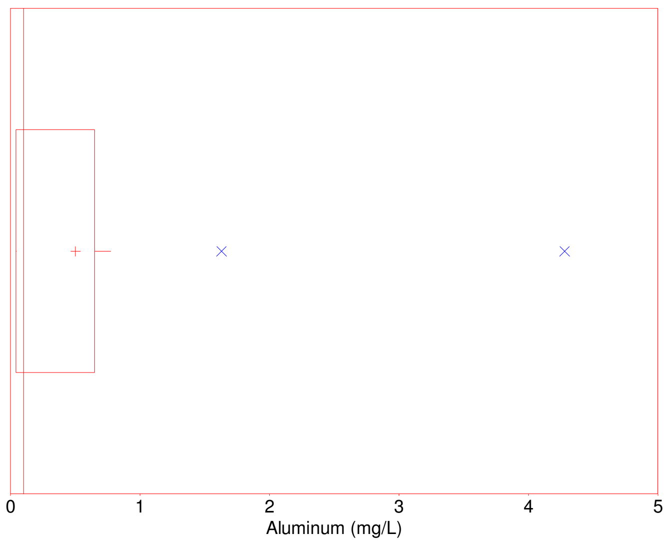
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally

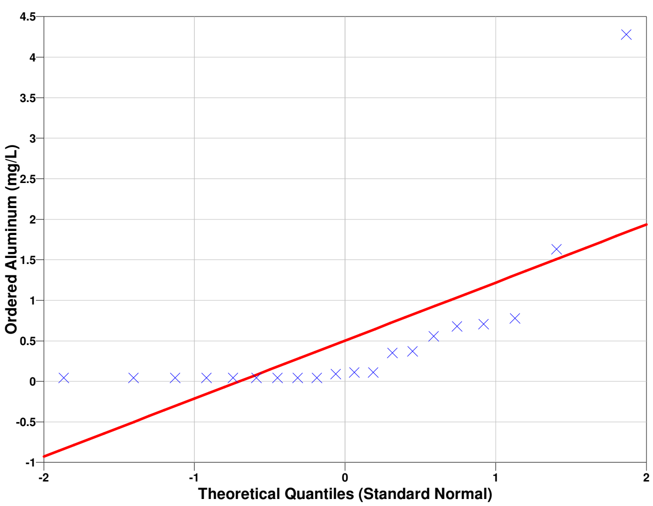
distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Aluminum

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was

conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.523
Shapiro-Wilk 5% Critical Value	0.905

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.8806
95% Non-Parametric (Chebyshev) UCL	1.455

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (1.455) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=20 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=19 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-8.8923	1.7291	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
19	14	Reject

Data Analysis for Arsenic
The following data points were entered by the user for analysis.

Arsenic (mg/L)

Rank	1	2	3	4	5	6	7	8	9	10
0	0.00135	0.00135	0.00135	0.00135	0.00135	0.00135	0.0027	0.0028	0.0035	0.0038
10	0.0046	0.0066	0.0075	0.0082	0.0095	0.0105	0.01665	0.0195	0.0211	0.0437

SUMMARY STATISTICS for Arsenic								
n	20							
Min	0.00135							
Max	0.0437							
Range	0.04235							
Mean	0.0084375							
Median	0.0042							
Variance	0.00010684							
StdDev	0.010336							
Std Error	0.0023113							
Skewness	2.3832							
Interquartile Range	0.0089							
Percentiles								
1%	5%	10%	25%	50%	75%	90%	95%	99%
0.00135	0.00135	0.00135	0.00135	0.0042	0.01025	0.02094	0.04257	0.0437

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Arsenic	
Dixon Test Statistic	0
Dixon 5% Critical Value	0.45

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.00135 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7205
Shapiro-Wilk 5% Critical Value	0.901

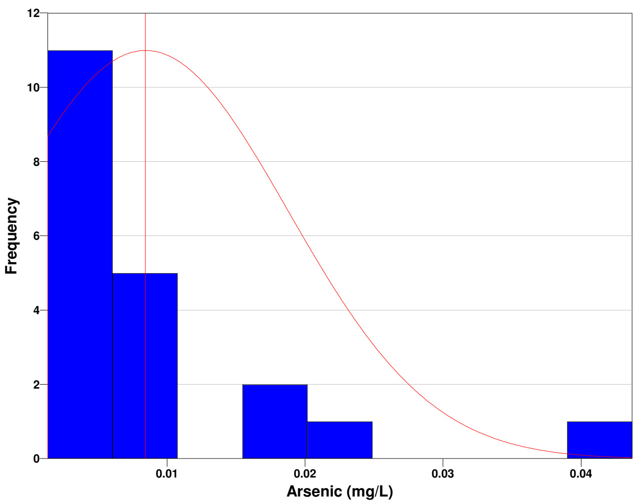
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.00135, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

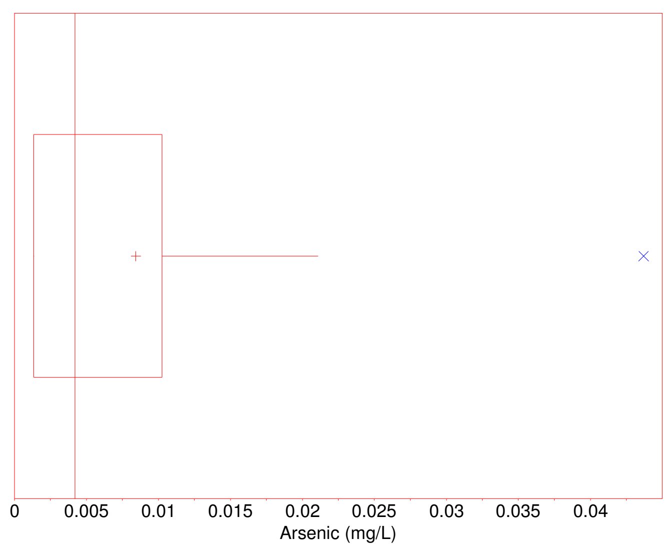
Data Plots for Arsenic
Graphical displays of the data are shown below.

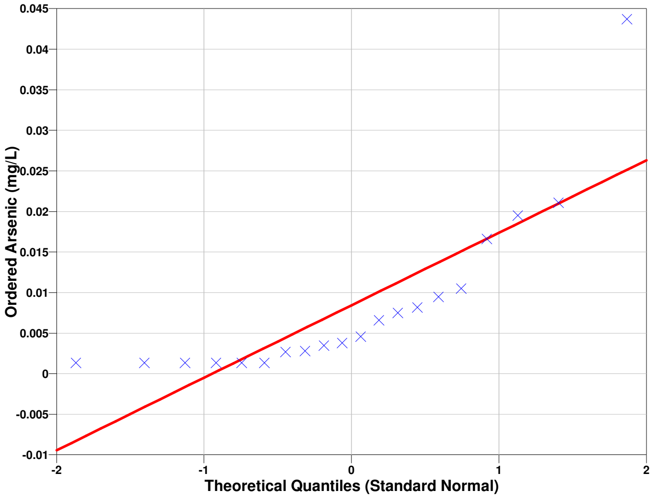
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Arsenic
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7075
Shapiro-Wilk 5% Critical Value	0.905

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.01243
95% Non-Parametric (Chebyshev) UCL	0.01851

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.01851) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=20 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=19 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-0.67603	1.7291	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
15	14	Reject

Data Analysis for Barium
The following data points were entered by the user for analysis.

Barium (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0186	0.0271	0.0511	0.0543	0.058	0.05835	0.0714	0.0836	0.137	0.139
10	0.139	0.238	0.251	0.251	0.28	0.287	0.295	0.322	0.331	0.557

SUMMARY STATISTICS for Barium								
n	20							
Min	0.0186							
Max	0.557							
Range	0.5384							
Mean	0.18247							
Median	0.139							
Variance	0.019522							
StdDev	0.13972							
Std Error	0.031243							
Skewness	0.94072							
Interquartile Range	0.22716							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0186	0.01903	0.0295	0.05809	0.139	0.2853	0.3301	0.5457	0.557

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any

values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Barium	
Dixon Test Statistic	0.10712
Dixon 5% Critical Value	0.45

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.0186 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8899
Shapiro-Wilk 5% Critical Value	0.901

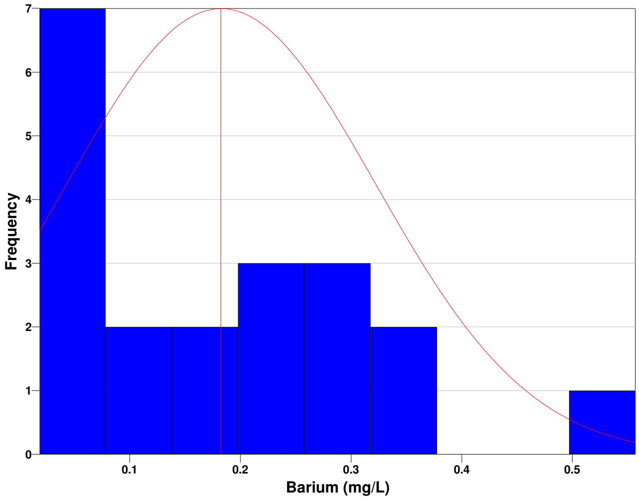
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.0186, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

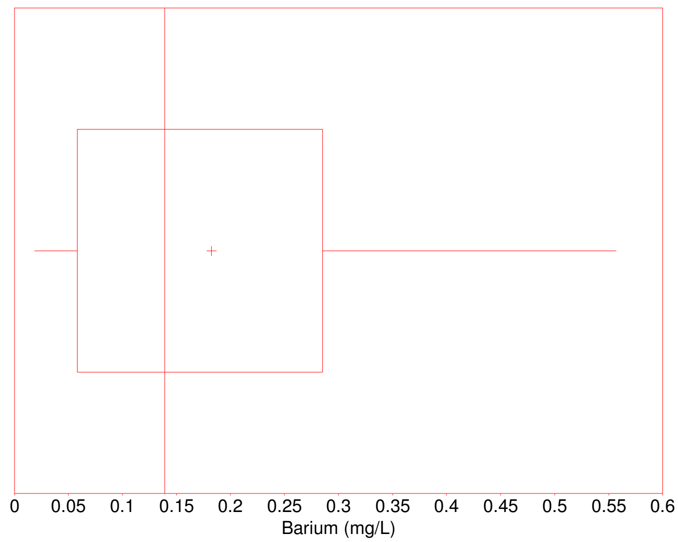
Data Plots for Barium
Graphical displays of the data are shown below.

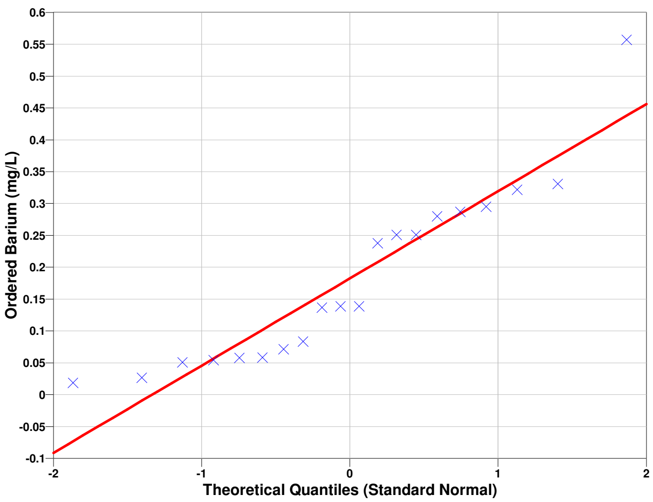
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Barium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8903
Shapiro-Wilk 5% Critical Value	0.905

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.2365

95% Non-Parametric (Chebyshev) UCL	0.3187

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.3187) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=20 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=19 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-58.175	1.7291	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
20	14	Reject

Data Analysis for Benzene
The following data points were entered by the user for analysis.

Benzene (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.000115	0.000115	0.000115	0.000115	0.000115	0.00023	0.00023	0.00023	0.00023	0.00023
10	0.00023	0.00023	0.00023	0.00023	0.00023	0.00023	0.00065	0.0012	0.003	0.0145

SUMMARY STATISTICS for Benzene	
n	20
Min	0.000115
Max	0.0145
Range	0.014385
Mean	0.0011228
Median	0.00023

Variance				1.0345e-005				
StdDev				0.0032163				
Std Error				0.00071919				
Skewness				4.1962				
Interquartile Range				8.625e-005				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.000115	0.000115	0.000115	0.0001438	0.00023	0.00023	0.00282	0.01392	0.0145

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Benzene	
Dixon Test Statistic	0
Dixon 5% Critical Value	0.45

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.000115 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.3471
Shapiro-Wilk 5% Critical Value	0.901

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.000115, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

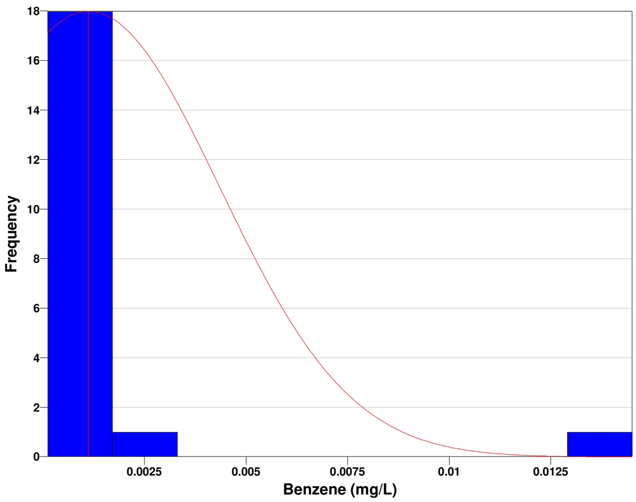
Data Plots for Benzene
Graphical displays of the data are shown below.

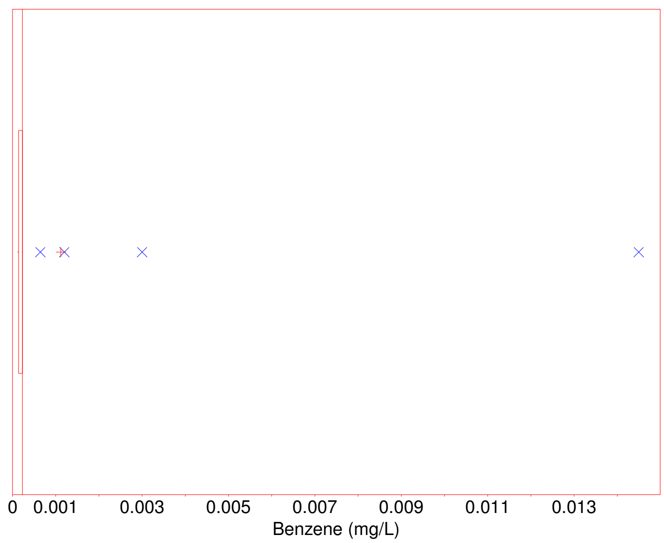
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

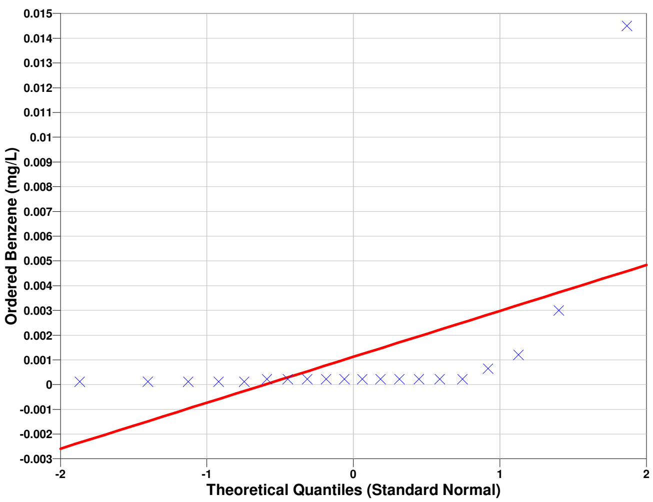
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends

to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Benzene

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.3376
Shapiro-Wilk 5% Critical Value	0.905

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.002366
95% Non-Parametric (Chebyshev) UCL	0.004258

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.004258) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=20 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=19 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-5.3911	1.7291	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
19	14	Reject

Data Analysis for bis(2-Ethylhexyl)phthalate
The following data points were entered by the user for analysis.

bis(2-Ethylhexyl)phthalate (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075
10	0.00075	0.00075	0.00075	0.00075	0.00075	0.0015	0.0016	0.0018	0.0026	0.006625

SUMMARY STATISTICS for bis(2-Ethylhexyl)phthalate								
n	20							
Min	0.00075							
Max	0.006625							
Range	0.005875							
Mean	0.0012688							
Median	0.00075							
Variance	1.8391e-006							
StdDev	0.0013561							
Std Error	0.00030324							
Skewness	3.6139							
Interquartile Range	0.0005625							
Percentiles								
1%	5%	10%	25%	50%	75%	90%	95%	99%
0.00075	0.00075	0.00075	0.00075	0.00075	0.001313	0.00252	0.006424	0.006625

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for bis(2-Ethylhexyl)phthalate	
Dixon Test Statistic	0
Dixon 5% Critical Value	0.45

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.00075 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.4592
Shapiro-Wilk 5% Critical Value	0.901

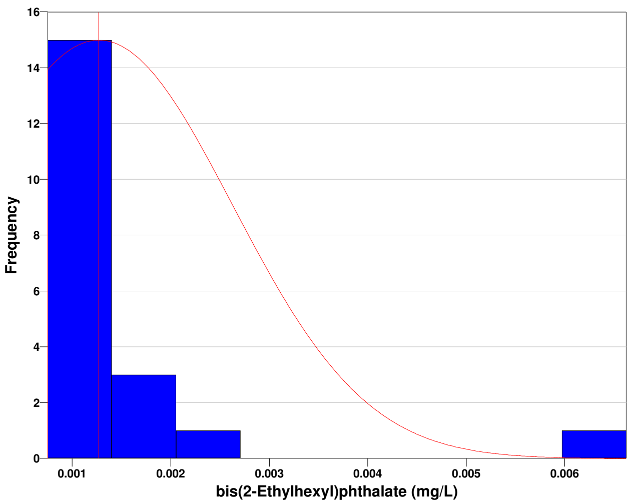
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.00075, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

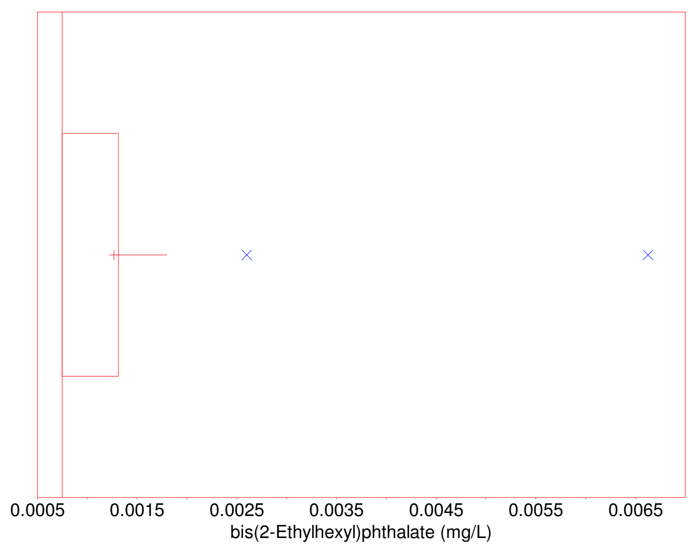
Data Plots for bis(2-Ethylhexyl)phthalate
Graphical displays of the data are shown below.

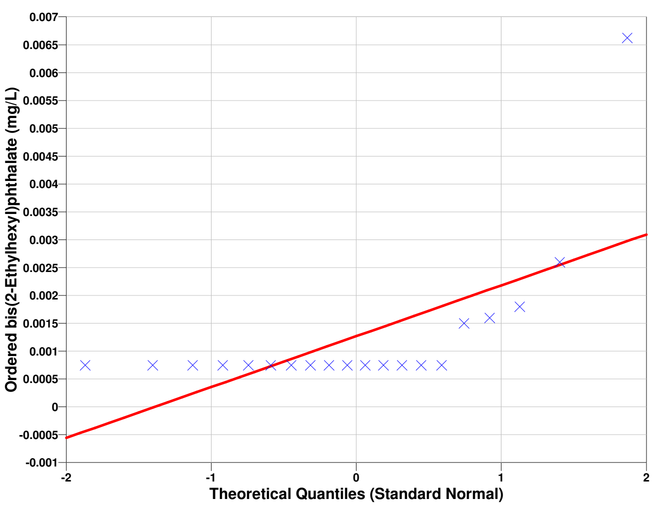
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through

2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for bis(2-Ethylhexyl)phthalate
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.4461
Shapiro-Wilk 5% Critical Value	0.905

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.001793
95% Non-Parametric (Chebyshev) UCL	0.002591

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.002591) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=20 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=19 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-11.652	1.7291	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
19	14	Reject

Data Analysis for Cyclohexane
The following data points were entered by the user for analysis.

Cyclohexane (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.000265	0.000265	0.000265	0.000265	0.000265	0.000265	0.000265	0.000265	0.000265	0.000265
10	0.000265	0.000265	0.000265	0.000265	0.000265	0.000265	0.00058	0.00068	0.00076	0.0323

SUMMARY STATISTICS for Cyclohexane								
n	20							
Min	0.000265							
Max	0.0323							
Range	0.032035							
Mean	0.001928							
Median	0.000265							
Variance	5.1129e-005							
StdDev	0.0071504							
Std Error	0.0015989							
Skewness	4.4688							
Interquartile Range	0							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.000265	0.000265	0.000265	0.000265	0.000265	0.000265	0.000752	0.03072	0.0323

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Cyclohexane	
Dixon Test Statistic	0
Dixon 5% Critical Value	0.45

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.000265 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)

Shapiro-Wilk Test Statistic	0.2556
Shapiro-Wilk 5% Critical Value	0.901

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.000265, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

Data Plots for Cyclohexane
Graphical displays of the data are shown below.

The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

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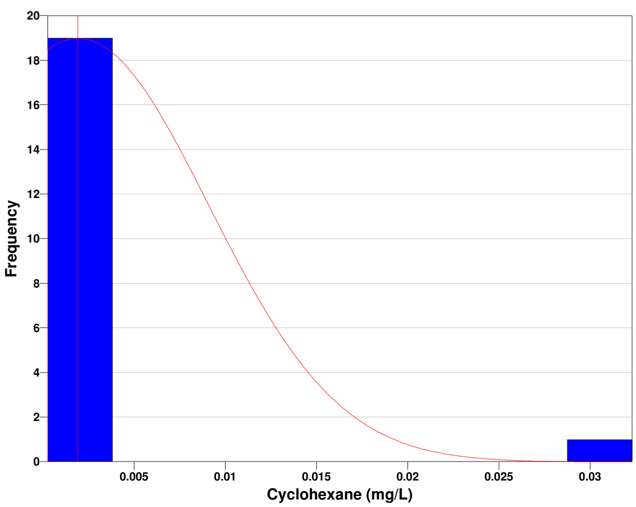
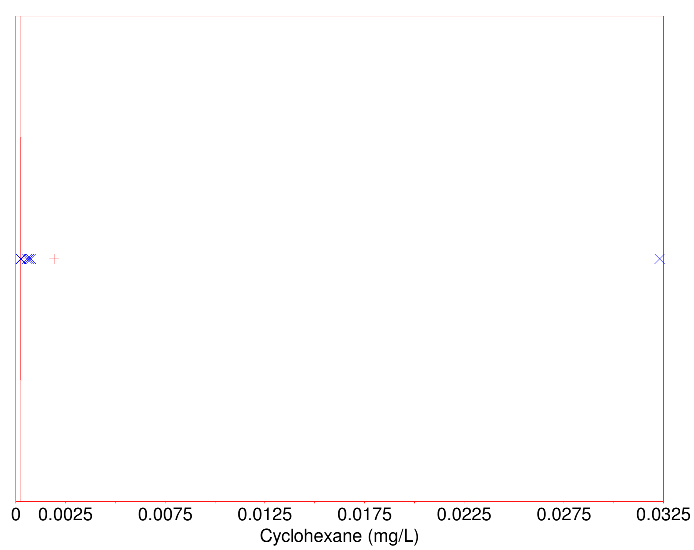
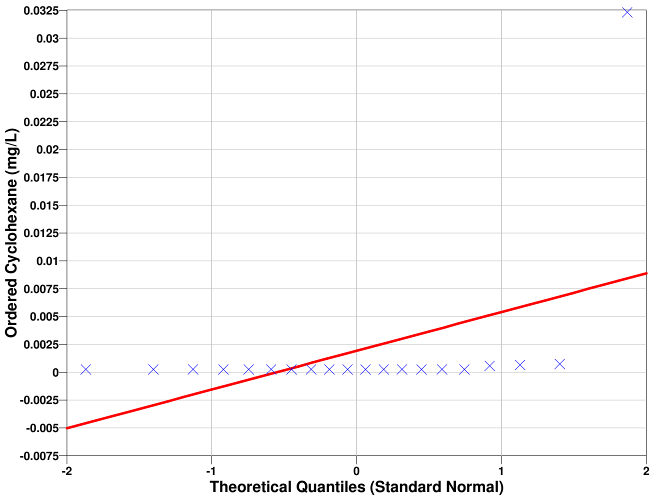
The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Cyclohexane
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.2472
Shapiro-Wilk 5% Critical Value	0.905

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.004693
95% Non-Parametric (Chebyshev) UCL	0.008897

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.008897) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=20 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=19 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-7825.7	1.7291	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
20	14	Reject

Data Analysis for Ethylbenzene
The following data points were entered by the user for analysis.

Ethylbenzene (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.000225	0.000225	0.000225	0.000225	0.000225	0.000225	0.000225	0.000225	0.000225	0.000225
10	0.000225	0.00024	0.00024	0.00024	0.00024	0.00058	0.002	0.0034	0.0038	0.008

SUMMARY STATISTICS for Ethylbenzene								
n	20							
Min	0.000225							
Max	0.008							
Range	0.007775							
Mean	0.0010607							
Median	0.000225							
Variance	3.8221e-006							
StdDev	0.001955							
Std Error	0.00043716							
Skewness	2.8142							
Interquartile Range	0.00027							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.000225	0.000225	0.000225	0.000225	0.000225	0.000495	0.00376	0.00779	0.008

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any

values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Ethylbenzene	
Dixon Test Statistic	0
Dixon 5% Critical Value	0.45

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.000225 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5236
Shapiro-Wilk 5% Critical Value	0.901

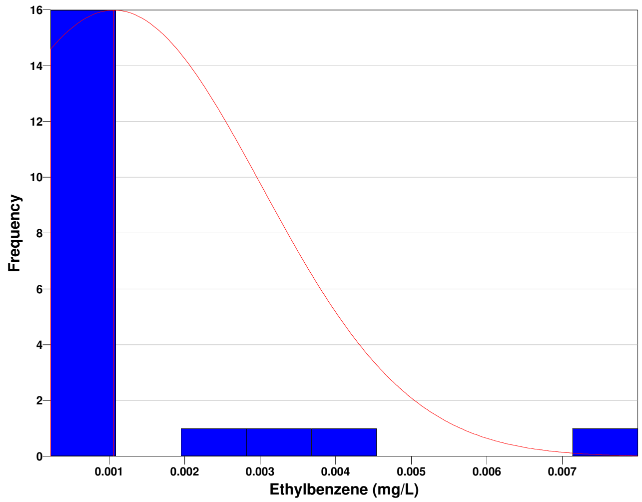
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.000225, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

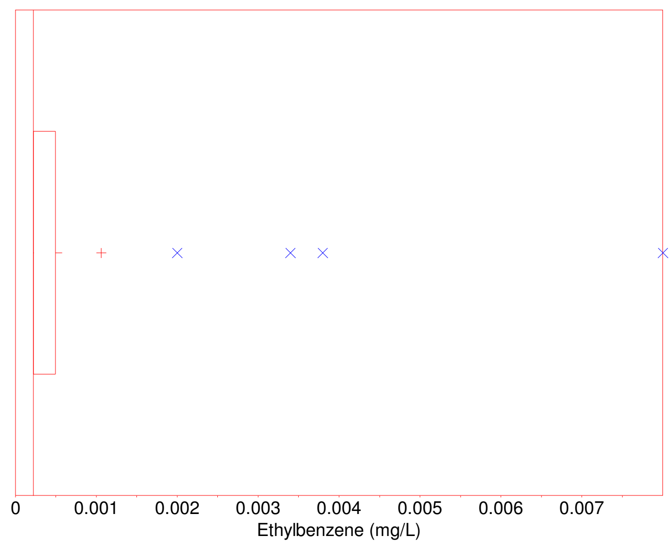
Data Plots for Ethylbenzene
Graphical displays of the data are shown below.

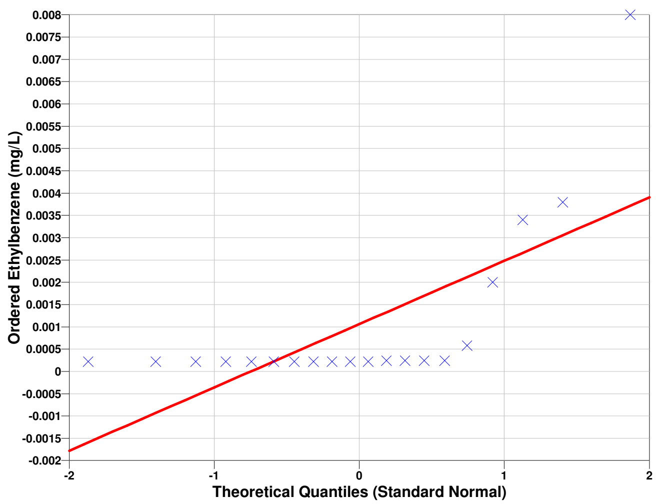
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Ethylbenzene

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5087
Shapiro-Wilk 5% Critical Value	0.905

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.001817

95% Non-Parametric (Chebyshev) UCL	0.002966

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.002966) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=20 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=19 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1598.8	1.7291	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
20	14	Reject

Data Analysis for Lead
The following data points were entered by the user for analysis.

Lead (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014
10	0.0014	0.0014	0.0014	0.0014	0.0044	0.0057	0.0072	0.0087	0.01	0.0195

SUMMARY STATISTICS for Lead	
n	20
Min	0.0014
Max	0.0195
Range	0.0181
Mean	0.003755
Median	0.0014

Variance				2.1319e-005				
StdDev				0.0046173				
Std Error				0.0010325				
Skewness				2.4555				
Interquartile Range				0.003975				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0014	0.0014	0.0014	0.0014	0.0014	0.005375	0.00987	0.01902	0.0195

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Lead	
Dixon Test Statistic	0
Dixon 5% Critical Value	0.45

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.0014 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6121
Shapiro-Wilk 5% Critical Value	0.901

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.0014, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

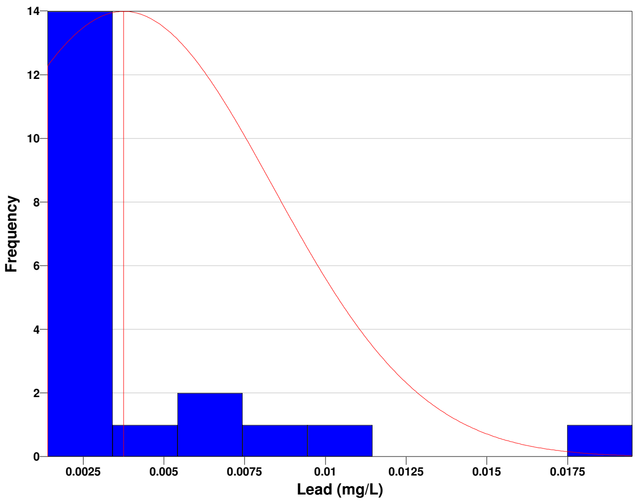
Data Plots for Lead
Graphical displays of the data are shown below.

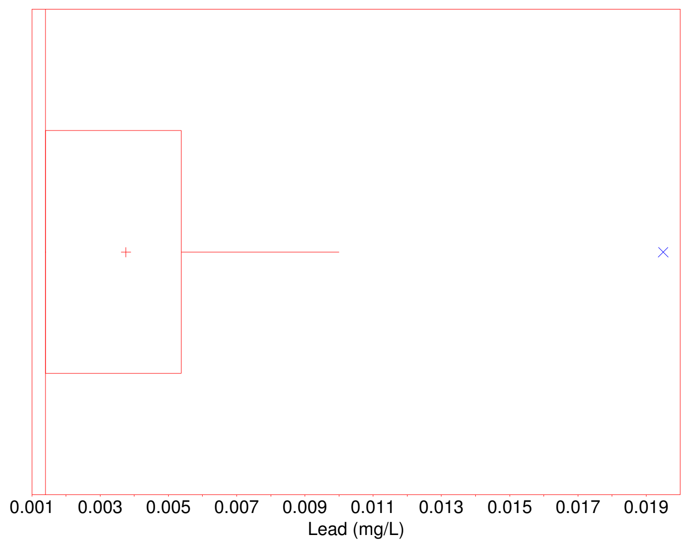
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

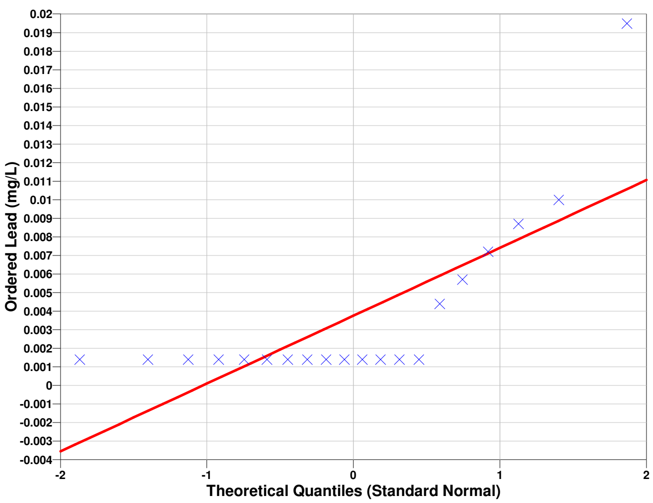
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends

to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Lead
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5959
Shapiro-Wilk 5% Critical Value	0.905

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.00554
95% Non-Parametric (Chebyshev) UCL	0.008255

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.008255) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=20 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=19 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-10.891	1.7291	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
19	14	Reject

Data Analysis for Manganese
The following data points were entered by the user for analysis.

Manganese (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.11	0.111	0.118	0.139	0.146	0.17	0.276	0.324	0.3525	0.394
10	0.4525	0.746	0.776	0.826	0.968	0.994	1.01	2.14	2.15	4.12

SUMMARY STATISTICS for Manganese								
n				20				
Min				0.11				
Max				4.12				
Range				4.01				
Mean				0.81615				
Median				0.42325				
Variance				0.96915				
StdDev				0.98446				
Std Error				0.22013				
Skewness				2.3505				
Interquartile Range				0.8355				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.11	0.1101	0.1117	0.152	0.4233	0.9875	2.149	4.021	4.12

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Manganese	
Dixon Test Statistic	0.0039409
Dixon 5% Critical Value	0.45

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.11 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7169
Shapiro-Wilk 5% Critical Value	0.901

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.11, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

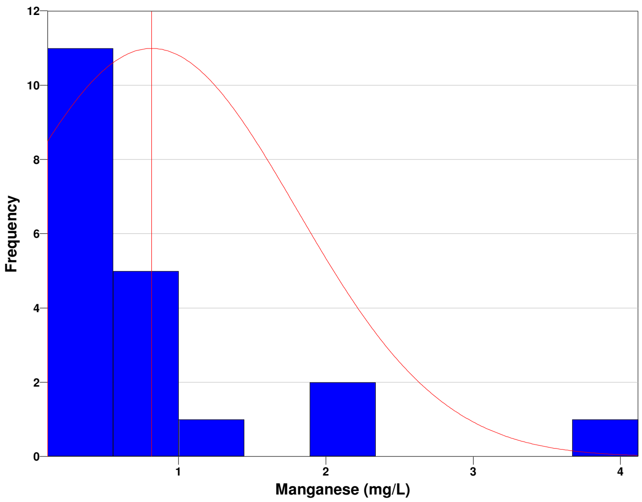
Data Plots for Manganese
Graphical displays of the data are shown below.

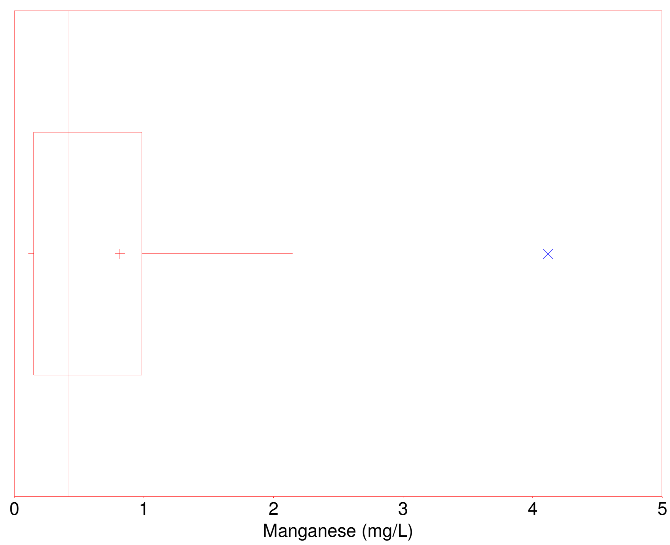
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

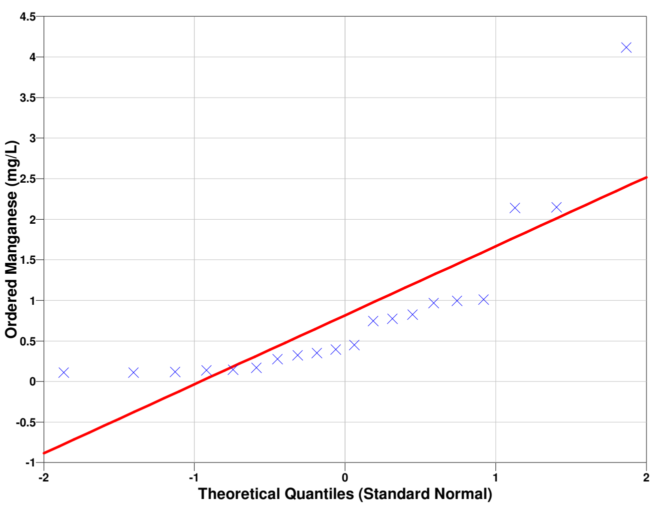
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Manganese
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.707
Shapiro-Wilk 5% Critical Value	0.905

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	1.197
95% Non-Parametric (Chebyshev) UCL	1.776

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (1.776) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=20 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=19 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.511	1.7291	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
17	14	Reject

Data Analysis for Naphthalene
The following data points were entered by the user for analysis.

Naphthalene (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075
10	0.00075	0.00075	0.00075	0.00075	0.00075	0.0021	0.0053	0.0256	0.0273	0.163

SUMMARY STATISTICS for Naphthalene	
n	20
Min	0.00075
Max	0.163
Range	0.16225
Mean	0.011728
Median	0.00075
Variance	0.0013295
StdDev	0.036462
Std Error	0.0081531
Skewness	4.1585
Interquartile Range	0.0010125

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00075	0.00075	0.00075	0.00075	0.00075	0.001763	0.02713	0.1562	0.163

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Naphthalene	
Dixon Test Statistic	0
Dixon 5% Critical Value	0.45

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.00075 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.3524
Shapiro-Wilk 5% Critical Value	0.901

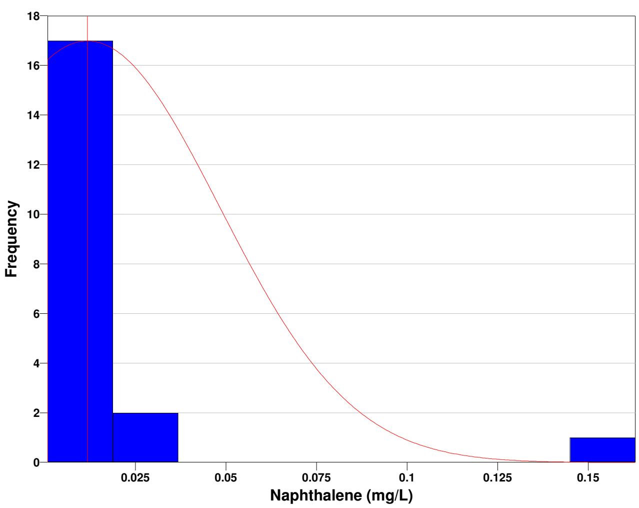
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.00075, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

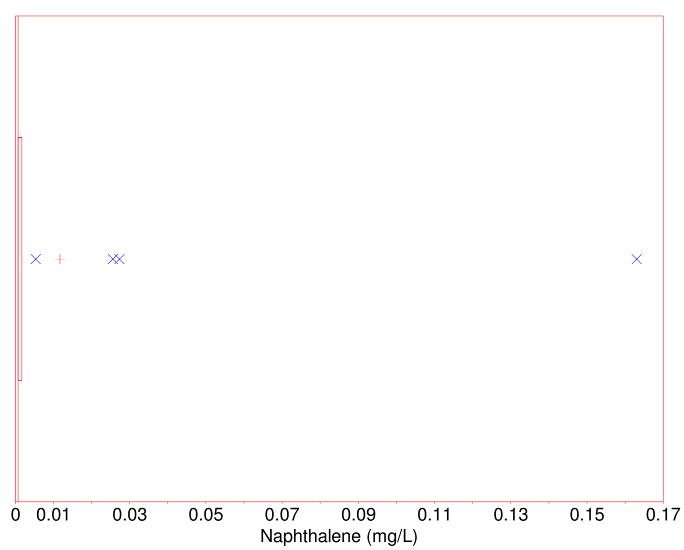
Data Plots for Naphthalene
Graphical displays of the data are shown below.

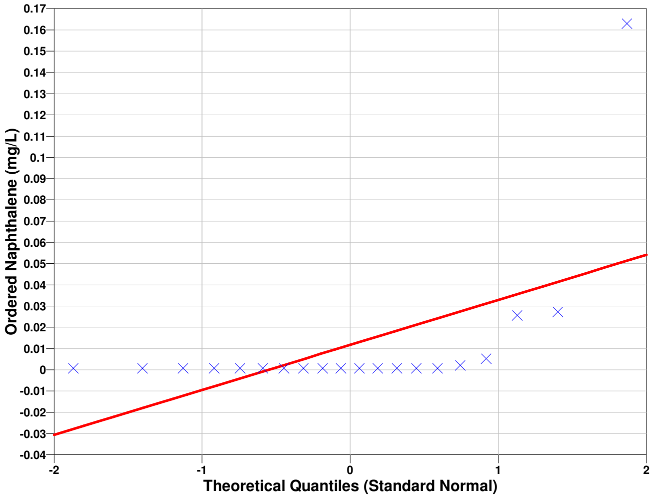
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Naphthalene
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.3416
Shapiro-Wilk 5% Critical Value	0.905

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.02583
95% Non-Parametric (Chebyshev) UCL	0.04727

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.04727) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=20 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=19 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
0.6776	1.7291	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
17	14	Reject

Data Analysis for Nickel
The following data points were entered by the user for analysis.

Nickel (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013
10	0.0013	0.0013	0.0029	0.0032	0.0035	0.00435	0.0063	0.0067	0.0099	0.0516

SUMMARY STATISTICS for Nickel								
n	20							
Min	0.0013							
Max	0.0516							
Range	0.0503							
Mean	0.0052025							
Median	0.0013							
Variance	0.00012494							
StdDev	0.011178							
Std Error	0.0024994							
Skewness	4.1559							
Interquartile Range	0.0028375							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0013	0.0013	0.0013	0.0013	0.0013	0.004137	0.00958	0.04951	0.0516

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any

values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Nickel	
Dixon Test Statistic	0
Dixon 5% Critical Value	0.45

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.0013 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.3927
Shapiro-Wilk 5% Critical Value	0.901

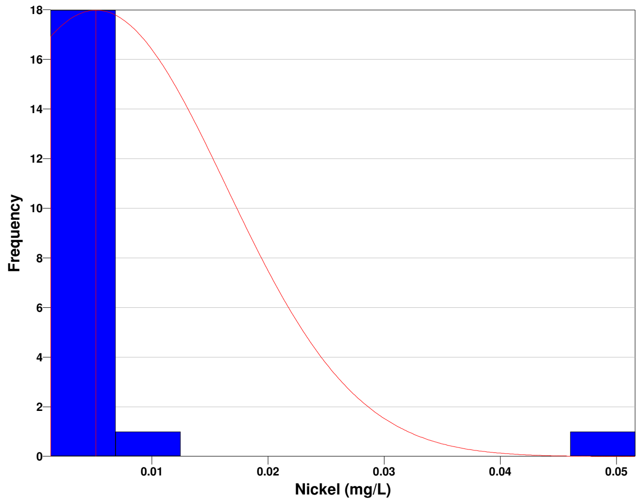
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.0013, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

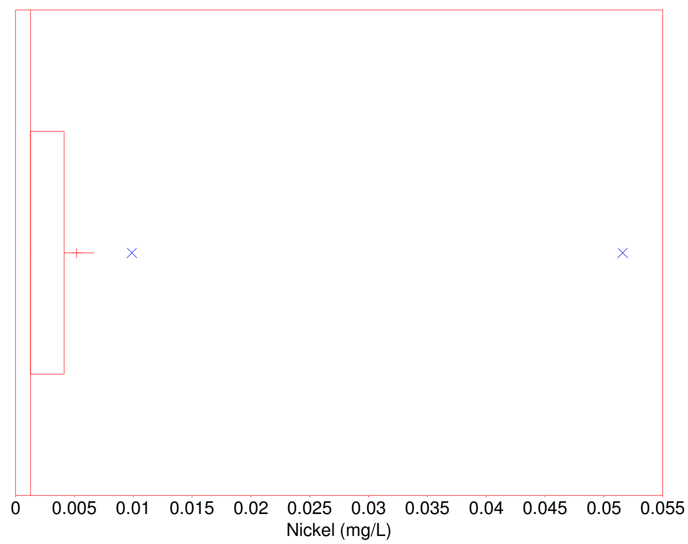
Data Plots for Nickel
Graphical displays of the data are shown below.

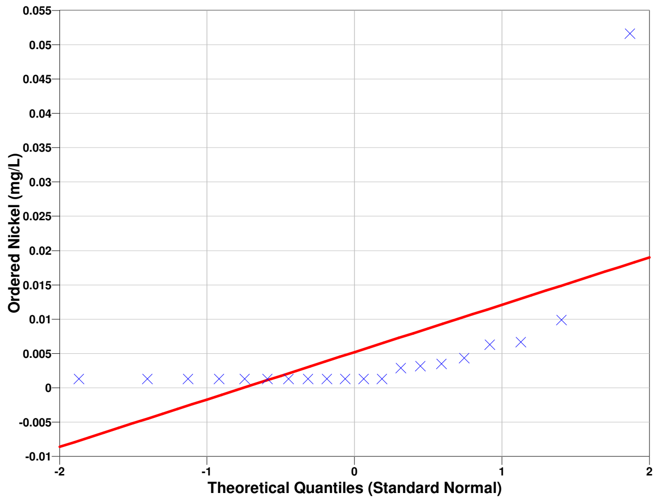
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Nickel
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.382
Shapiro-Wilk 5% Critical Value	0.905

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.009524

95% Non-Parametric (Chebyshev) UCL	0.0161

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.0161) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=20 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=19 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-193.5	1.7291	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
20	14	Reject

Data Analysis for Thallium
The following data points were entered by the user for analysis.

Thallium (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00135	0.00135	0.00135	0.00135	0.00135	0.00135	0.00135	0.002225	0.0035	0.0035
10	0.0037	0.0041	0.0042	0.0048	0.0048	0.0048	0.0051	0.0051	0.0062	0.0067

SUMMARY STATISTICS for Thallium	
n	20
Min	0.00135
Max	0.0067
Range	0.00535
Mean	0.0034087
Median	0.0036

Variance				3.2856e-006				
StdDev				0.0018126				
Std Error				0.00040532				
Skewness				0.13024				
Interquartile Range				0.00345				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00135	0.00135	0.00135	0.00135	0.0036	0.0048	0.00609	0.006675	0.0067

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Thallium	
Dixon Test Statistic	0
Dixon 5% Critical Value	0.45

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.00135 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8889
Shapiro-Wilk 5% Critical Value	0.901

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.00135, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

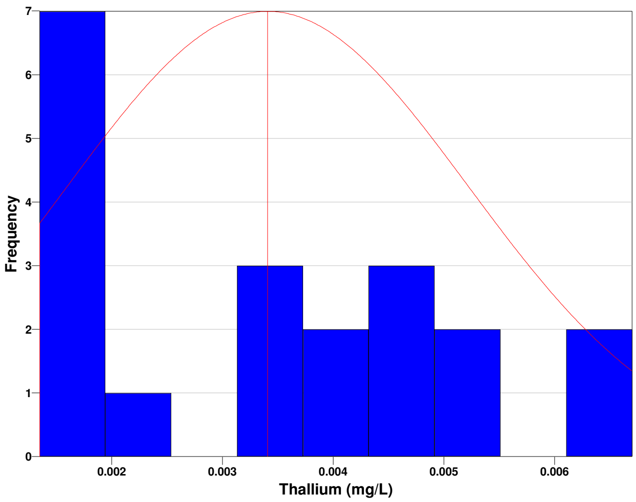
Data Plots for Thallium
Graphical displays of the data are shown below.

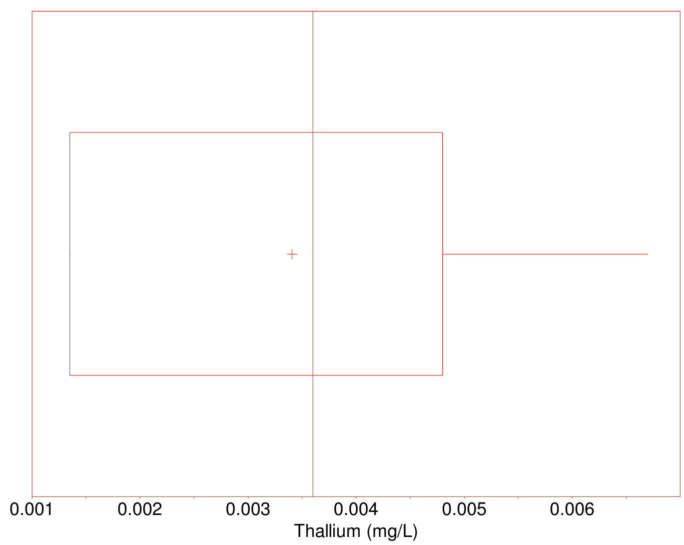
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

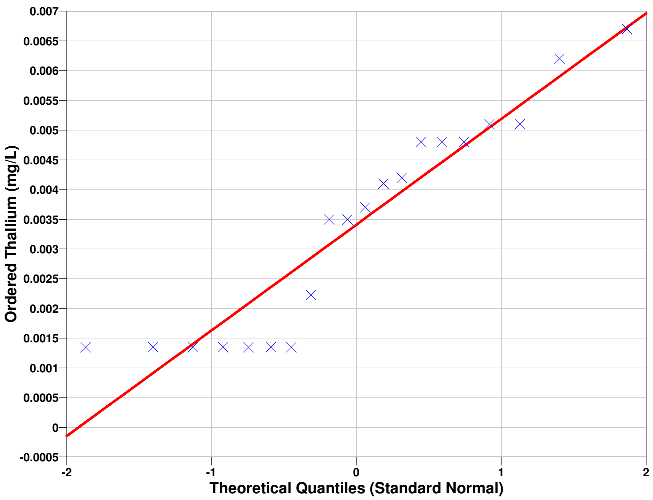
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends

to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Thallium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8757
Shapiro-Wilk 5% Critical Value	0.905

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.00411
95% Non-Parametric (Chebyshev) UCL	0.005175

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.005175) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=20 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=19 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
3.4757	1.7291	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	14	Cannot Reject
Note: There may not be enough data to reject the null hypothesis (and conclude site is clean) with 95% confidence using the MARSSIM sign test.		

Data Analysis for Vanadium
The following data points were entered by the user for analysis.

Vanadium (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

0	0.00047	0.00047	0.00047	0.00047	0.00047	0.00047	0.0011	0.0011	0.0011	0.0012
10	0.0013	0.0015	0.0018	0.0019	0.0021	0.00215	0.0025	0.0033	0.0136	0.01665

SUMMARY STATISTICS for Vanadium								
n	20							
Min	0.00047							
Max	0.01665							
Range	0.01618							
Mean	0.002706							
Median	0.00125							
Variance	1.89e-005							
StdDev	0.0043474							
Std Error	0.0009721							
Skewness	2.7866							
Interquartile Range	0.0016675							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00047	0.00047	0.00047	0.00047	0.00125	0.002138	0.01257	0.0165	0.01665

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Vanadium	
Dixon Test Statistic	0
Dixon 5% Critical Value	0.45

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.00047 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5301
Shapiro-Wilk 5% Critical Value	0.901

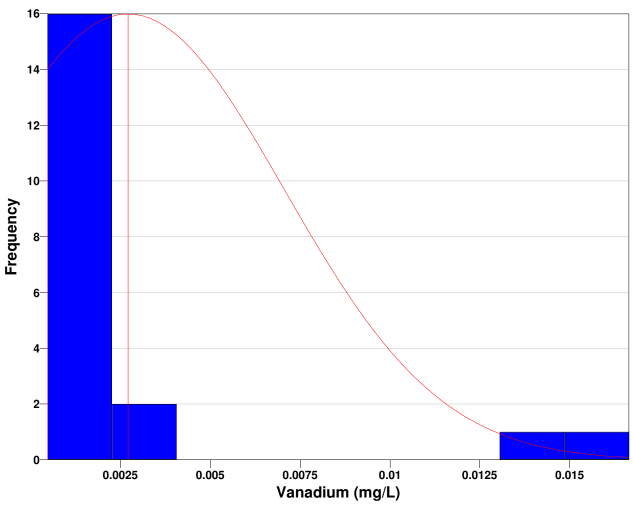
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.00047, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

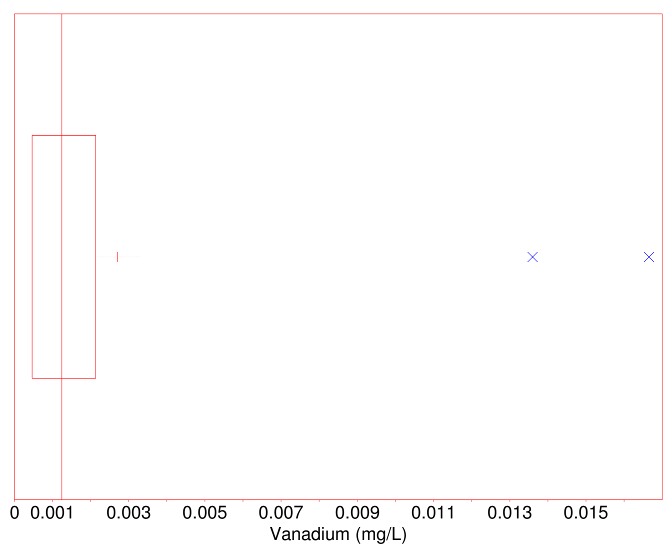
Data Plots for Vanadium
Graphical displays of the data are shown below.

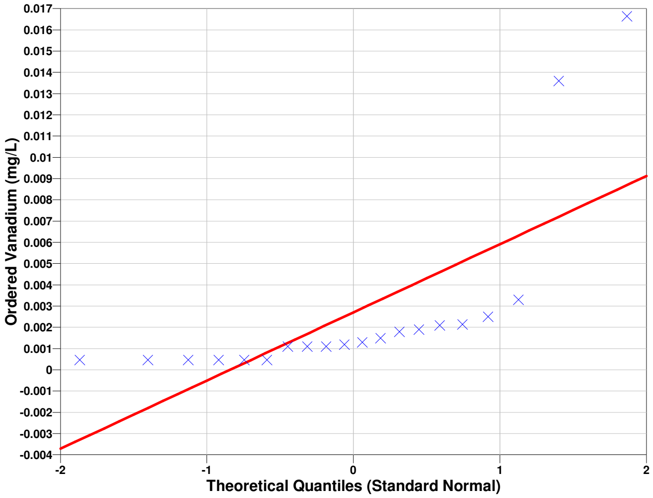
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Vanadium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5207
Shapiro-Wilk 5% Critical Value	0.905

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.004387
95% Non-Parametric (Chebyshev) UCL	0.006943

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.006943) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=20 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=19 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-173.22	1.7291	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
20	14	Reject

Data Analysis for Zinc
The following data points were entered by the user for analysis.

Zinc (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0123	0.0127	0.0128	0.0133	0.014	0.0143	0.0151	0.0155	0.0155	0.0156
10	0.0165	0.01665	0.01695	0.0215	0.0216	0.0484	0.0495	0.0552	0.0564	0.196

SUMMARY STATISTICS for Zinc	
n	20
Min	0.0123
Max	0.196
Range	0.1837
Mean	0.03199
Median	0.01605
Variance	0.0017232
StdDev	0.041511
Std Error	0.0092823
Skewness	3.5788
Interquartile Range	0.027625

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0123	0.01232	0.01271	0.01408	0.01605	0.0417	0.05628	0.189	0.196

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any

values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Zinc	
Dixon Test Statistic	0.011655
Dixon 5% Critical Value	0.45

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.0123 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5017
Shapiro-Wilk 5% Critical Value	0.901

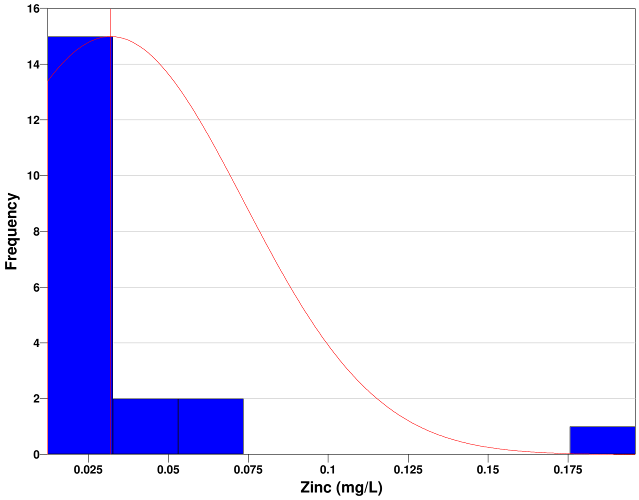
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.0123, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

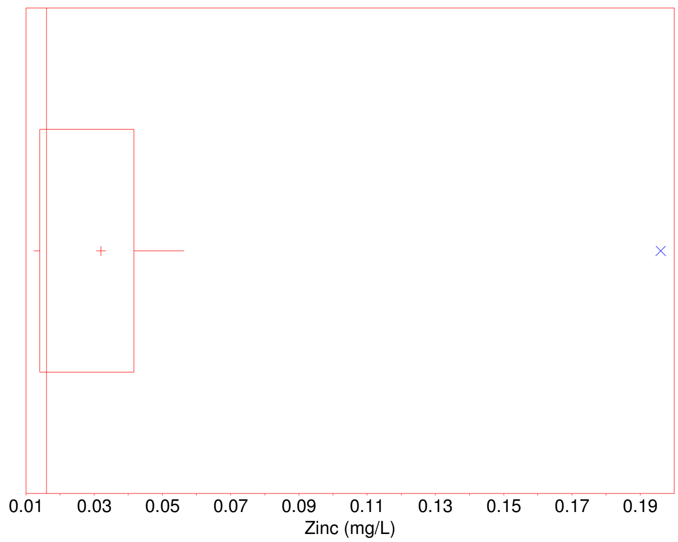
Data Plots for Zinc
Graphical displays of the data are shown below.

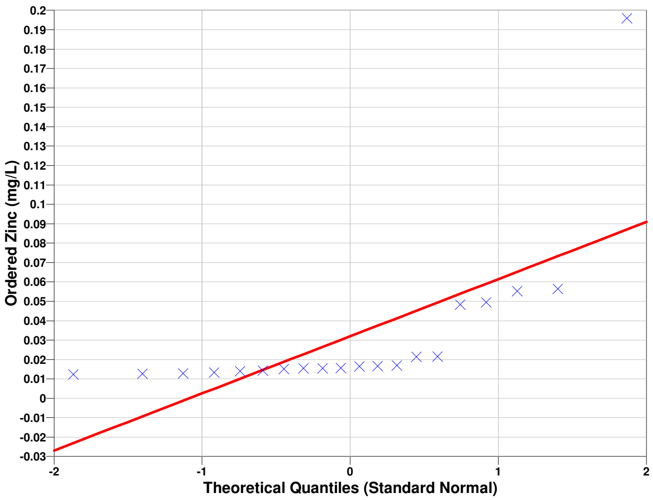
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Zinc
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.4927
Shapiro-Wilk 5% Critical Value	0.905

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.04804

95% Non-Parametric (Chebyshev) UCL	0.07245

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.07245) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=20 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=19 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-786.51	1.7291	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
20	14	Reject

Data Analysis for 1-Methylnaphthalene
The following data points were entered by the user for analysis.

1-Methylnaphthalene (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00085	0.00085	0.00085	0.00085	0.00085	0.00085	0.00085	0.00085	0.00085	0.00085
10	0.00085	0.00085	0.00085	0.00085	0.00085	0.0009	0.002	0.0109	0.0155	0.0647

SUMMARY STATISTICS for 1-Methylnaphthalene	
n	20
Min	0.00085
Max	0.0647
Range	0.06385
Mean	0.0053375
Median	0.00085

Variance				0.00021005				
StdDev				0.014493				
Std Error				0.0032408				
Skewness				4.0134				
Interquartile Range				3.75e-005				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00085	0.00085	0.00085	0.00085	0.00085	0.0008875	0.01504	0.06224	0.0647

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for 1-Methylnaphthalene	
Dixon Test Statistic	0
Dixon 5% Critical Value	0.45

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.00085 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.3686
Shapiro-Wilk 5% Critical Value	0.901

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.00085, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

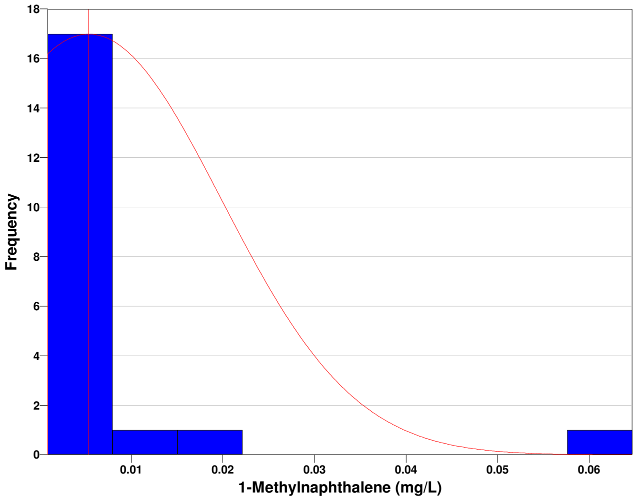
Data Plots for 1-Methylnaphthalene
Graphical displays of the data are shown below.

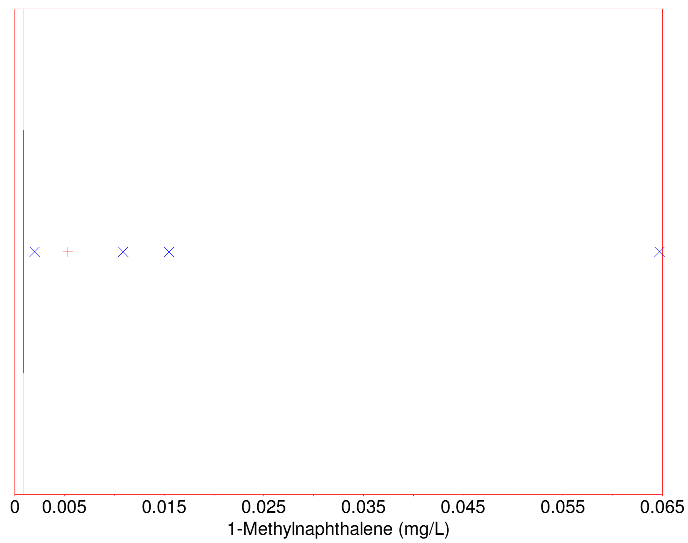
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

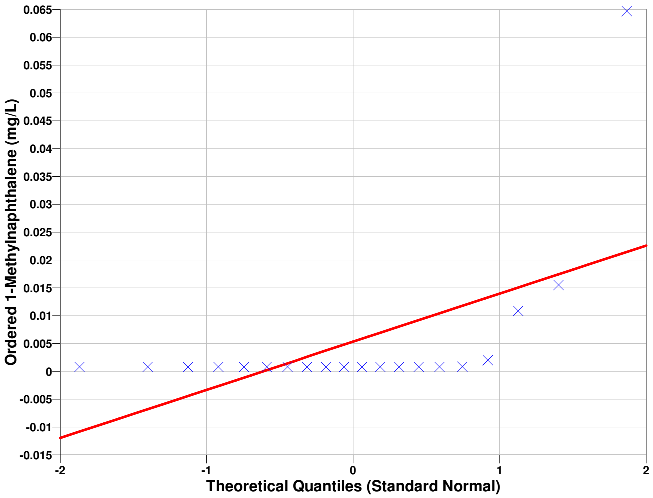
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends

to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for 1-Methylnaphthalene

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.3572
Shapiro-Wilk 5% Critical Value	0.905

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.01094
95% Non-Parametric (Chebyshev) UCL	0.01946

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.01946) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=20 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=19 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-526.29	1.7291	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
20	14	Reject

This report was automatically produced* by Visual Sample Plan (VSP) software version 5.3.1.
Software and documentation available at http://dqo.pnl.gov/vsp

* - The report contents may have been modified or reformatted by end-user of software.

Appendix C

VSP Reports of Calculated Minimum Sample Quantity
Report 10
Area of Concern – 1
Minimum Sample Quantity Calculation for Groundwater using Human Health Benchmarks and Delta Method 2

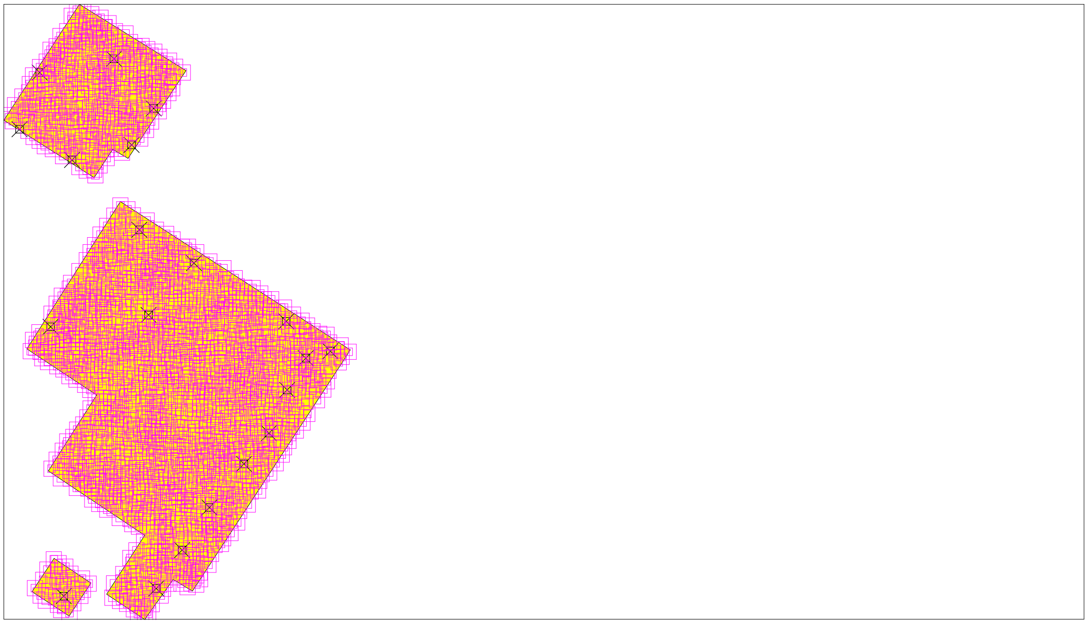
Random sampling locations for comparing a mean with a fixed threshold (parametric)

Summary
This report summarizes the sampling design, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design for Naphthalene, the driving analyte (the analyte which required the largest number of samples). A figure that shows sampling locations in the field is also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean to a fixed threshold
Type of Sampling Design	Parametric
Sample Placement (Location) in the Field	Simple random sampling
Working (Null) Hypothesis	The mean value at the site exceeds the threshold
Formula for calculating number of sampling locations	Student's t-test
Calculated total number of samples	1185
Number of samples on map [a]	1185
Number of selected sample areas [b]	1
Specified sampling area [c]	188054.34 m^2
Total cost of sampling [d]	$593,500.00

[a] This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[d] Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.



Primary Sampling Objective
The primary purpose of sampling at this site is to compare a mean value of a site with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the mean value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the mean value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative hypothesis, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach
A parametric random sampling approach was used to determine the number of samples and to specify sampling locations. A parametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that parametric assumptions are reasonable. These assumptions will be examined in post-sampling data analysis.

Both parametric and non-parametric approaches rely on assumptions about the population. However, non-parametric approaches typically require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than the number of samples required by non-parametric approaches.

Locating the sample points randomly provides data that are separated by many distances, whereas systematic samples are all equidistant apart. Therefore, random sampling provides more information about the spatial structure of the potential contamination than systematic sampling does. As with systematic sampling, random sampling also provides information regarding the mean value, but there is the possibility that areas of the site will not be represented with the same frequency as if uniform grid sampling were performed.

Number of Total Samples: Calculation Equation and Inputs
The equation used to calculate the number of samples is based on a Student's t-test. For this site, the null hypothesis is rejected in favor of the alternative hypothesis if the sample mean is sufficiently smaller than the threshold. The number of samples to collect is calculated so that 1) there will be a high probability ($1-\beta$) of rejecting the null hypothesis if the alternative hypothesis is true and 2) a low probability (α) of rejecting the null hypothesis if the null hypothesis is true.

The formula used to calculate the number of samples is:

$$n = \frac{S^2}{\Delta^2}\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2 + 0.5Z_{1-\alpha}^2$$

where
n is the number of samples,
S is the estimated standard deviation of the measured values including analytical error,
Δ is the width of the gray region,
α is the acceptable probability of incorrectly concluding the site mean is less than the threshold,
β is the acceptable probability of incorrectly concluding the site mean exceeds the threshold,
$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is $1-\alpha$,
$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is $1-\beta$.

The values of these inputs that result in the calculated number of sampling locations are:

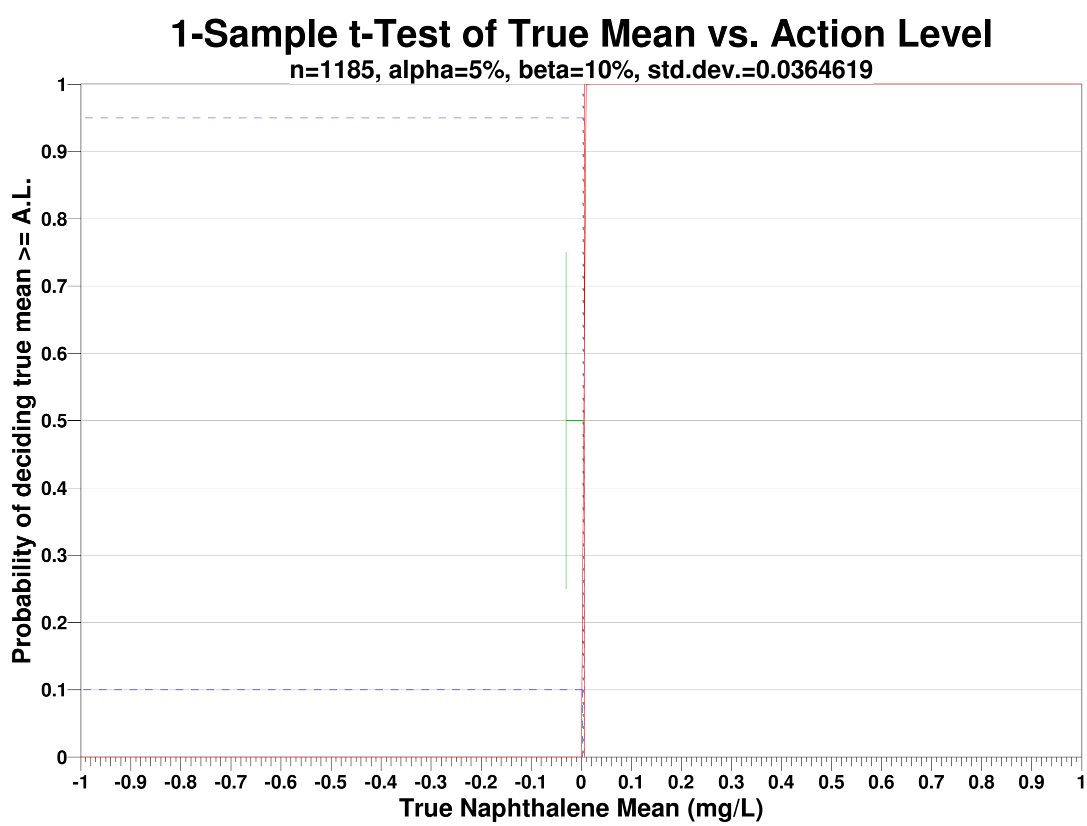
Analyte	n	Parameter					
		S	Δ	α	β	$Z_{1-\alpha}$ [a]	$Z_{1-\beta}$ [b]
00_New_Sample	2	0.1 mg/L	10 mg/L	0.05	0.1	1.64485	1.28155
Acetone	2	0.00226616 mg/L	2.7375 mg/L	0.05	0.1	1.64485	1.28155
Aluminum	7	0.976173 mg/L	1.2221 mg/L	0.05	0.1	1.64485	1.28155
Arsenic	38	0.0103365 mg/L	0.005 mg/L	0.05	0.1	1.64485	1.28155
Barium	2	0.139721 mg/L	1 mg/L	0.05	0.1	1.64485	1.28155
Benzene	16	0.00321632 mg/L	0.0025 mg/L	0.05	0.1	1.64485	1.28155
bis(2-Ethylhexyl)phthalate	5	0.00135615 mg/L	0.00240113 mg/L	0.05	0.1	1.64485	1.28155

Cyclohexane	2	0.00715044 mg/L	6.25714 mg/L	0.05	0.1	1.64485	1.28155
Ethylbenzene	2	0.00195502 mg/L	0.35 mg/L	0.05	0.1	1.64485	1.28155
Lead	5	0.0046173 mg/L	0.0075 mg/L	0.05	0.1	1.64485	1.28155
Manganese	27	0.984455 mg/L	0.574386 mg/L	0.05	0.1	1.64485	1.28155
Naphthalene	1185	0.0364619 mg/L	0.00310147 mg/L	0.05	0.1	1.64485	1.28155
Nickel	2	0.0111778 mg/L	0.24442 mg/L	0.05	0.1	1.64485	1.28155
Thallium	30	0.00181263 mg/L	0.001 mg/L	0.05	0.1	1.64485	1.28155
Vanadium	2	0.00434736 mg/L	0.0855469 mg/L	0.05	0.1	1.64485	1.28155
Zinc	2	0.0415115 mg/L	3.66629 mg/L	0.05	0.1	1.64485	1.28155
1-Methylnaphthalene	2	0.0144932 mg/L	0.855469 mg/L	0.05	0.1	1.64485	1.28155

[a] This value is automatically calculated by VSP based upon the user defined value of α.
[b] This value is automatically calculated by VSP based upon the user defined value of β.

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000) for Naphthalene, the driving analyte. It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true mean values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at 1-α on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at 1-α. If any of the inputs change, the number of samples that result in the correct curve changes.



Statistical Assumptions

The assumptions associated with the formulas for computing the number of samples are:
1. the sample mean is normally distributed (this happens if the data are roughly symmetric or the sample size is more than 30; for extremely skewed data sets, additional samples may be required for the sample mean to be normally distributed),
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected randomly.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the sample locations were selected using a random process.

Sensitivity Analysis
The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that μ > action level and alpha (%), probability of mistakenly concluding that μ < action level. The following table shows the results of this analysis.

Number of Samples							
AL=7.33259		**α=5**		**α=10**		**α=15**	
		s=0.083023	**s=0.0415115**	**s=0.083023**	**s=0.0415115**	**s=0.083023**	**s=0.0415115**
LBGR=90	**β=5**	193874	48470	153417	38355	128793	32199
	β=10	153418	38356	117690	29423	96256	24065
	β=15	128794	32200	96256	24065	76975	19245
LBGR=80	**β=5**	48470	12119	38355	9590	32199	8051
	β=10	38356	9590	29423	7357	24065	6017
	β=15	32200	8051	24065	6017	19245	4812
LBGR=70	**β=5**	21543	5387	17048	4263	14311	3579
	β=10	17048	4263	13078	3270	10696	2675
	β=15	14312	3579	10696	2675	8554	2139

s = Standard Deviation
LBGR = Lower Bound of Gray Region (% of Action Level)
β = Beta (%), Probability of mistakenly concluding that μ > action level
α = Alpha (%), Probability of mistakenly concluding that μ < action level
AL = Action Level (Threshold)

Cost of Sampling
The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that are based on the number of samples collected and measured. Based on the numbers of samples determined above, the estimated total cost of sampling and analysis at this site is $593,500.00, which averages out to a per sample cost of $500.84. The following table summarizes the inputs and resulting cost estimates.

COST INFORMATION			
Cost Details	**Per Analysis**	**Per Sample**	**1185 Samples**
Field collection costs		$100.00	$118,500.00
Analytical costs	$400.00	$400.00	$474,000.00
Sum of Field & Analytical costs		**$500.00**	**$592,500.00**
Fixed planning and validation costs			$1,000.00
Total cost			**$593,500.00**

Data Analysis for 00_New_Sample

SUMMARY STATISTICS for 00_New_Sample

n				1165				
Min				0				
Max				0				
Range				0				
Mean				0				
Median				0				
Variance				0				
StdDev				0				
Std Error				0				
Skewness				-1.#IND				
Interquartile Range				0				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0	0	0	0	0	0	0	0	0

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for 00_New_Sample			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	0	-1	Yes

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Lilliefors test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Lilliefors Test Statistic	1.061e+292
Lilliefors 5% Critical Value	1.376e-313

The calculated Lilliefors test statistic exceeds the 5% Lilliefors critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

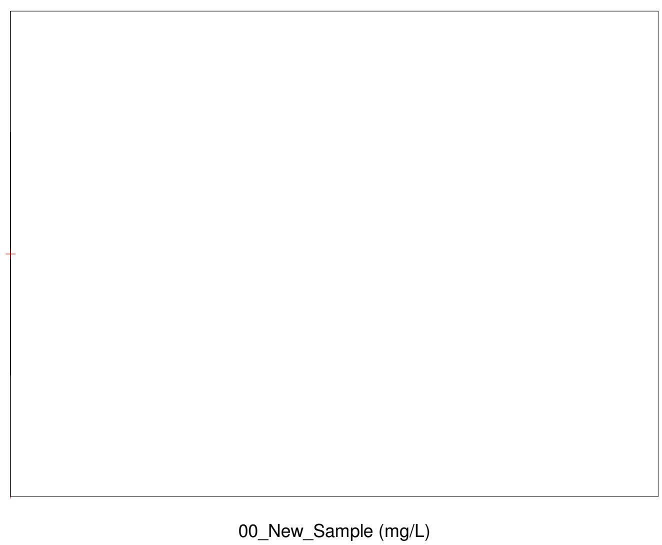
Data Plots for 00_New_Sample
Graphical displays of the data are shown below.

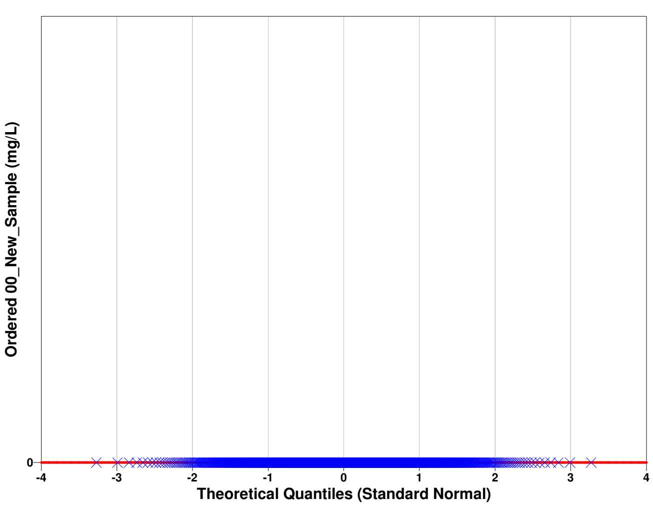
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.





For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for 00_New_Sample
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Lilliefors test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Lilliefors Test Statistic	0
Lilliefors 5% Critical Value	0.02596

The calculated Lilliefors test statistic is less than the 5% Lilliefors critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0
95% Non-Parametric (Chebyshev) UCL	0

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=1165 data,
AL is the action level or threshold (7.33259),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=1164 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.#IND	1.6462	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Data Analysis for Acetone
The following data points were entered by the user for analysis.

Acetone (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0013	0.0013	0.0014	0.00335	0.0036	0.0039	0.004	0.0041	0.00425	0.0047
10	0.005	0.0052	0.0055	0.0057	0.0057	0.0068	0.0073	0.0082	0.0087	0.0089

SUMMARY STATISTICS for Acetone								
n	20							
Min	0.0013							
Max	0.0089							
Range	0.0076							
Mean	0.004945							
Median	0.00485							
Variance	5.1355e-006							
StdDev	0.0022662							
Std Error	0.00050673							
Skewness	0.095243							
Interquartile Range	0.00285							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0013	0.0013	0.00131	0.003675	0.00485	0.006525	0.00865	0.00889	0.0089

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Acetone	
Dixon Test Statistic	0.014493
Dixon 5% Critical Value	0.45

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.0013 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9583
Shapiro-Wilk 5% Critical Value	0.901

The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.0013, do appear to follow a normal distribution at the 5% level of significance.

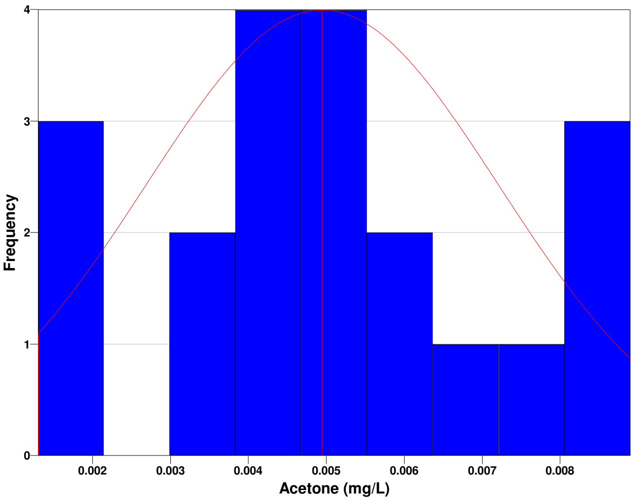
Data Plots for Acetone
Graphical displays of the data are shown below.

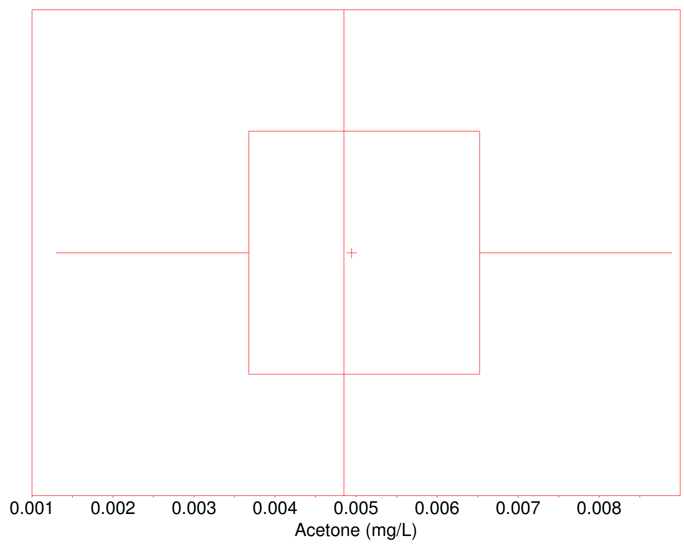
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The

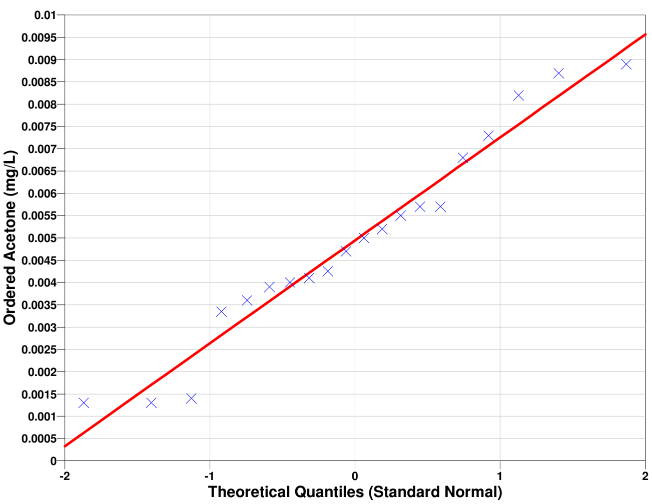
sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Acetone

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution.

The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9519
Shapiro-Wilk 5% Critical Value	0.905

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.005821
95% Non-Parametric (Chebyshev) UCL	0.007154

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0.005821) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=20 data,
AL is the action level or threshold (7.33259),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=19 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-10795	1.7291	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Aluminum
The following data points were entered by the user for analysis.

Aluminum (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.0911
10	0.113	0.113	0.354	0.372	0.558	0.68	0.709	0.777	1.63	4.28

SUMMARY STATISTICS for Aluminum

n				20				
Min				0.043				
Max				4.28				
Range				4.237				
Mean				0.50321				
Median				0.10205				
Variance				0.95291				
StdDev				0.97617				
Std Error				0.21828				
Skewness				3.4116				
Interquartile Range				0.6065				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.043	0.043	0.043	0.043	0.1021	0.6495	1.545	4.147	4.28

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Aluminum	
Dixon Test Statistic	0
Dixon 5% Critical Value	0.45

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.043 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5358
Shapiro-Wilk 5% Critical Value	0.901

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.043, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

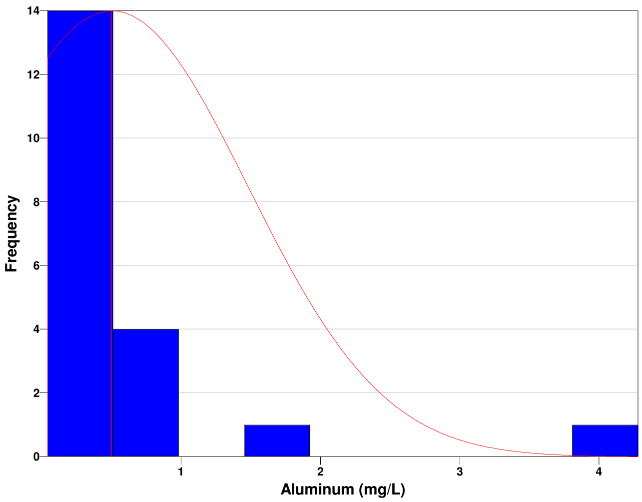
Data Plots for Aluminum
Graphical displays of the data are shown below.

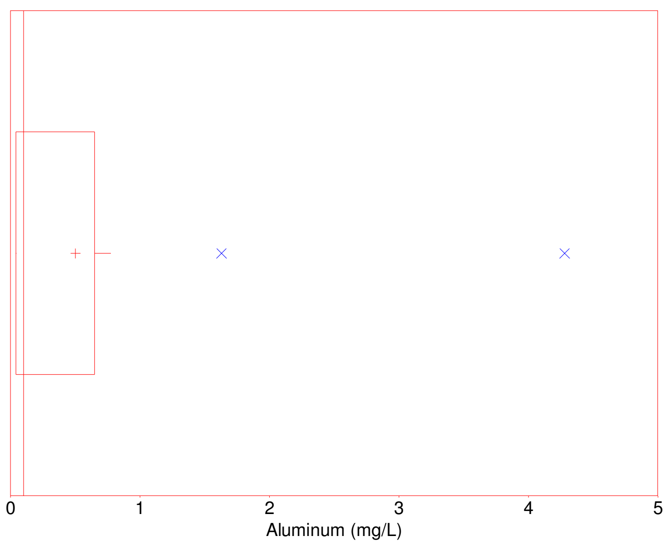
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each

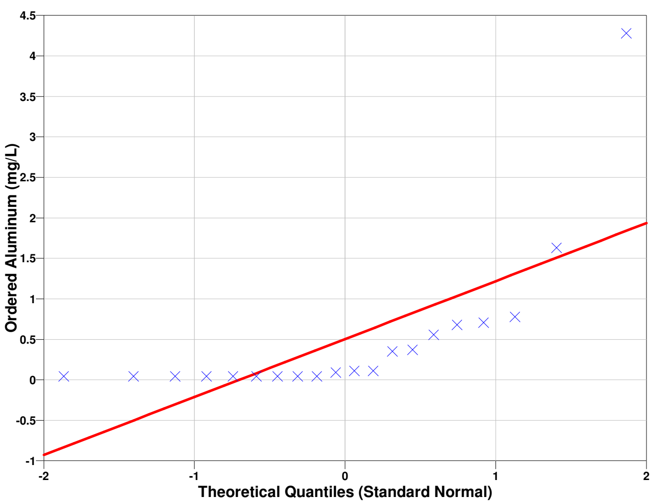
bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Aluminum
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.523
Shapiro-Wilk 5% Critical Value	0.905

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.8806
95% Non-Parametric (Chebyshev) UCL	1.455

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (1.455) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=20 data,
AL is the action level or threshold (7.33259),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=19 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-8.8923	1.7291	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
19	14	Reject

Data Analysis for Arsenic
The following data points were entered by the user for analysis.

Arsenic (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00135	0.00135	0.00135	0.00135	0.00135	0.00135	0.0027	0.0028	0.0035	0.0038
10	0.0046	0.0066	0.0075	0.0082	0.0095	0.0105	0.01665	0.0195	0.0211	0.0437

SUMMARY STATISTICS for Arsenic								
n	20							
Min	0.00135							
Max	0.0437							
Range	0.04235							
Mean	0.0084375							
Median	0.0042							
Variance	0.00010684							
StdDev	0.010336							
Std Error	0.0023113							
Skewness	2.3832							
Interquartile Range	0.0089							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00135	0.00135	0.00135	0.00135	0.0042	0.01025	0.02094	0.04257	0.0437

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Arsenic	
Dixon Test Statistic	0
Dixon 5% Critical Value	0.45

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.00135 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7205
Shapiro-Wilk 5% Critical Value	0.901

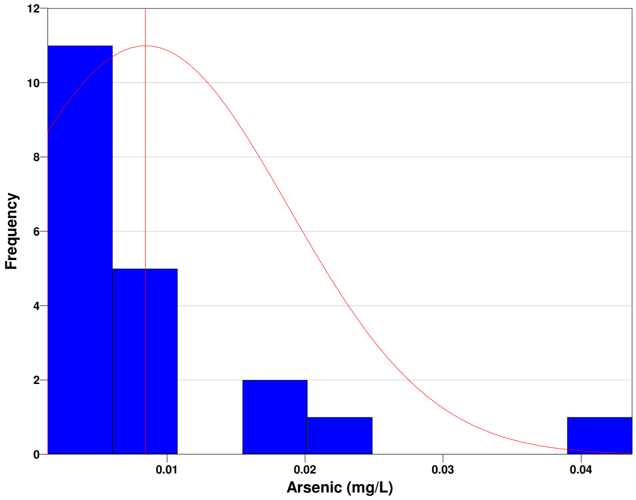
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.00135, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

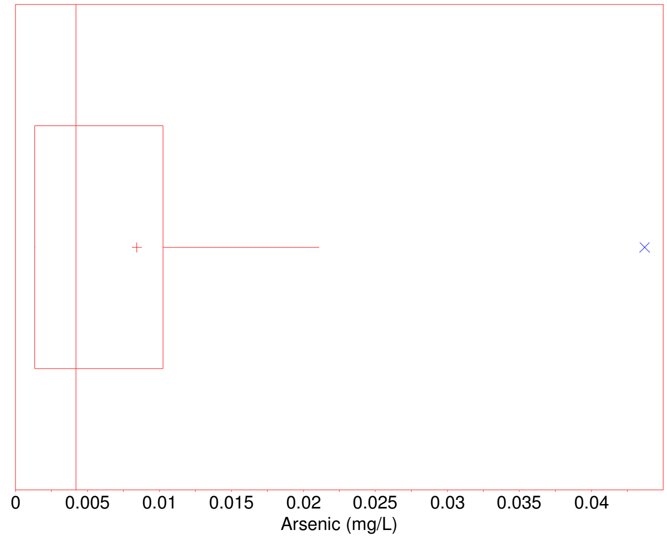
Data Plots for Arsenic
Graphical displays of the data are shown below.

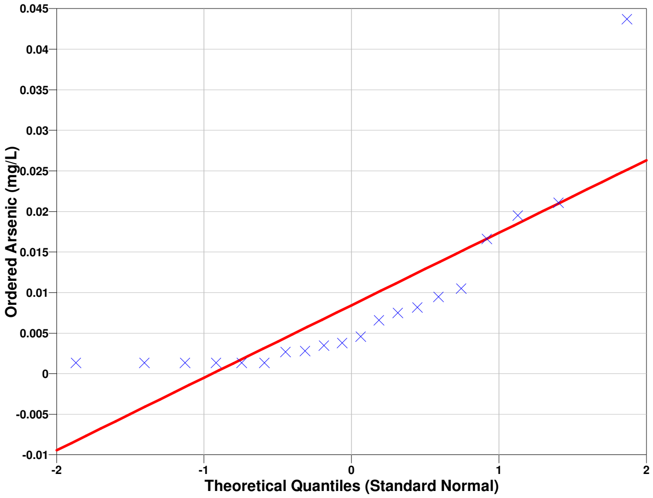
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Arsenic

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7075
Shapiro-Wilk 5% Critical Value	0.905

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.01243
95% Non-Parametric (Chebyshev) UCL	0.01851

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.01851) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test

A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where

x is the sample mean of the n=20 data,
AL is the action level or threshold (7.33259),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=19 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-0.67603	1.7291	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
15	14	Reject

Data Analysis for Barium
The following data points were entered by the user for analysis.

Barium (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0186	0.0271	0.0511	0.0543	0.058	0.05835	0.0714	0.0836	0.137	0.139
10	0.139	0.238	0.251	0.251	0.28	0.287	0.295	0.322	0.331	0.557

SUMMARY STATISTICS for Barium	
n	20
Min	0.0186
Max	0.557
Range	0.5384
Mean	0.18247
Median	0.139
Variance	0.019522
StdDev	0.13972
Std Error	0.031243
Skewness	0.94072
Interquartile Range	0.22716

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0186	0.01903	0.0295	0.05809	0.139	0.2853	0.3301	0.5457	0.557

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any

values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Barium	
Dixon Test Statistic	0.10712
Dixon 5% Critical Value	0.45

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.0186 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8899
Shapiro-Wilk 5% Critical Value	0.901

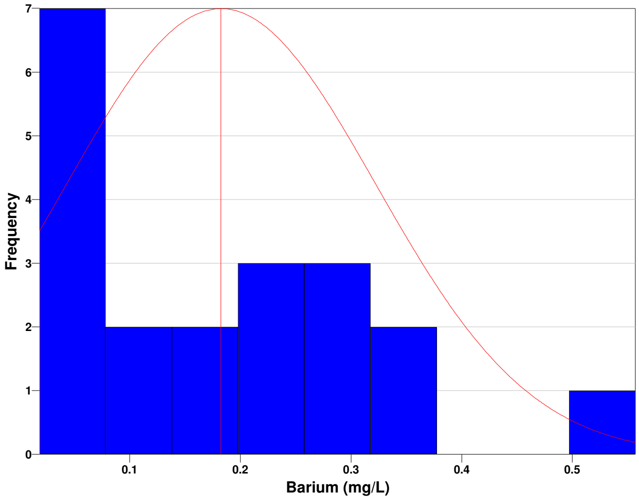
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.0186, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

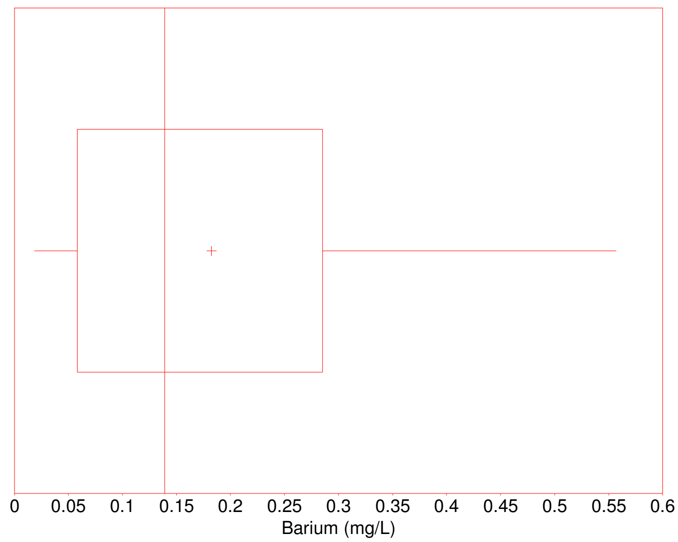
Data Plots for Barium
Graphical displays of the data are shown below.

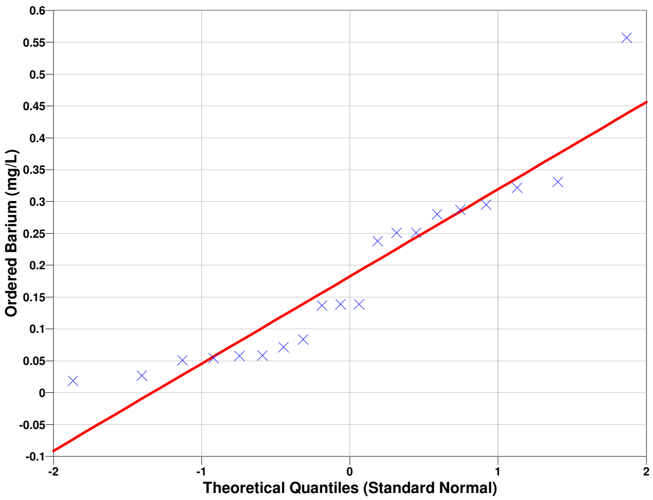
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Barium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8903
Shapiro-Wilk 5% Critical Value	0.905

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.2365

95% Non-Parametric (Chebyshev) UCL	0.3187

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.3187) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=20 data,
AL is the action level or threshold (7.33259),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=19 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-58.175	1.7291	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
20	14	Reject

Data Analysis for Benzene
The following data points were entered by the user for analysis.

Benzene (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.000115	0.000115	0.000115	0.000115	0.000115	0.00023	0.00023	0.00023	0.00023	0.00023
10	0.00023	0.00023	0.00023	0.00023	0.00023	0.00023	0.00065	0.0012	0.003	0.0145

SUMMARY STATISTICS for Benzene	
n	20
Min	0.000115
Max	0.0145
Range	0.014385
Mean	0.0011228
Median	0.00023

Variance				1.0345e-005				
StdDev				0.0032163				
Std Error				0.00071919				
Skewness				4.1962				
Interquartile Range				8.625e-005				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.000115	0.000115	0.000115	0.0001438	0.00023	0.00023	0.00282	0.01392	0.0145

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Benzene	
Dixon Test Statistic	0
Dixon 5% Critical Value	0.45

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.000115 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.3471
Shapiro-Wilk 5% Critical Value	0.901

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.000115, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

Data Plots for Benzene
Graphical displays of the data are shown below.

The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends

to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

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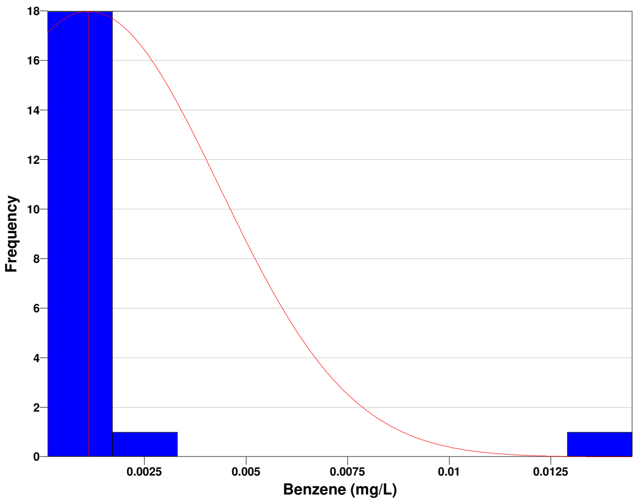
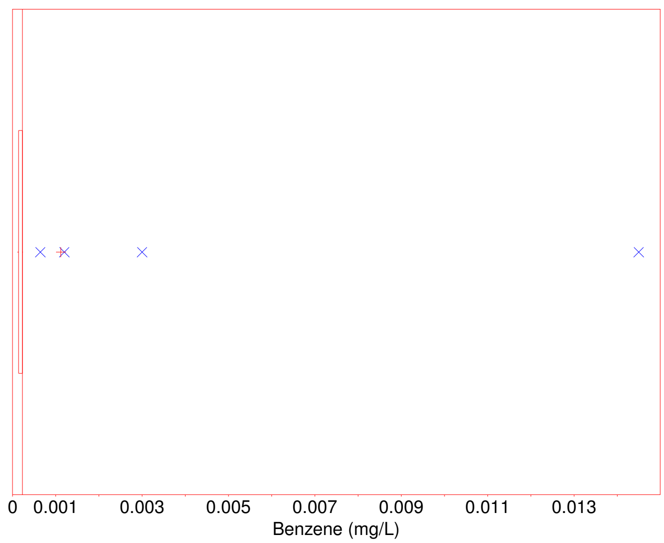
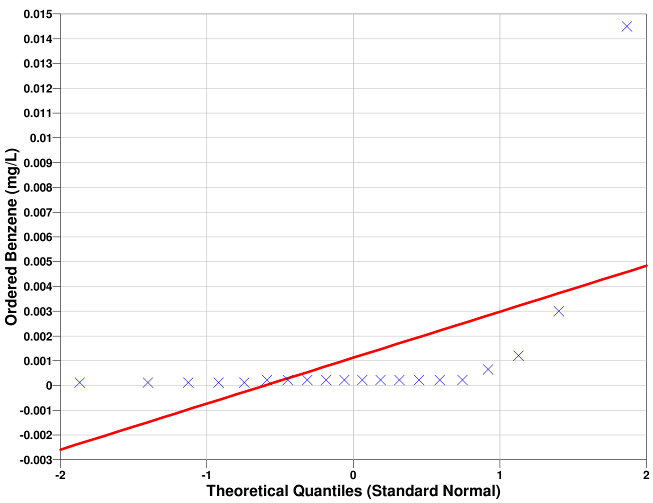






For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Benzene
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.3376
Shapiro-Wilk 5% Critical Value	0.905

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.002366
95% Non-Parametric (Chebyshev) UCL	0.004258

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.004258) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=20 data,
AL is the action level or threshold (7.33259),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=19 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-5.3911	1.7291	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
19	14	Reject

Data Analysis for bis(2-Ethylhexyl)phthalate
The following data points were entered by the user for analysis.

bis(2-Ethylhexyl)phthalate (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075
10	0.00075	0.00075	0.00075	0.00075	0.00075	0.0015	0.0016	0.0018	0.0026	0.006625

SUMMARY STATISTICS for bis(2-Ethylhexyl)phthalate								
n	20							
Min	0.00075							
Max	0.006625							
Range	0.005875							
Mean	0.0012688							
Median	0.00075							
Variance	1.8391e-006							
StdDev	0.0013561							
Std Error	0.00030324							
Skewness	3.6139							
Interquartile Range	0.0005625							
Percentiles								
1%	5%	10%	25%	50%	75%	90%	95%	99%
0.00075	0.00075	0.00075	0.00075	0.00075	0.001313	0.00252	0.006424	0.006625

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for bis(2-Ethylhexyl)phthalate	
Dixon Test Statistic	0
Dixon 5% Critical Value	0.45

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.00075 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.4592
Shapiro-Wilk 5% Critical Value	0.901

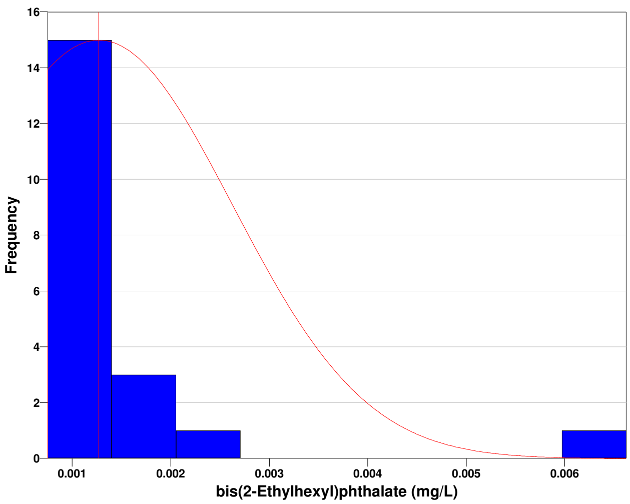
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.00075, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

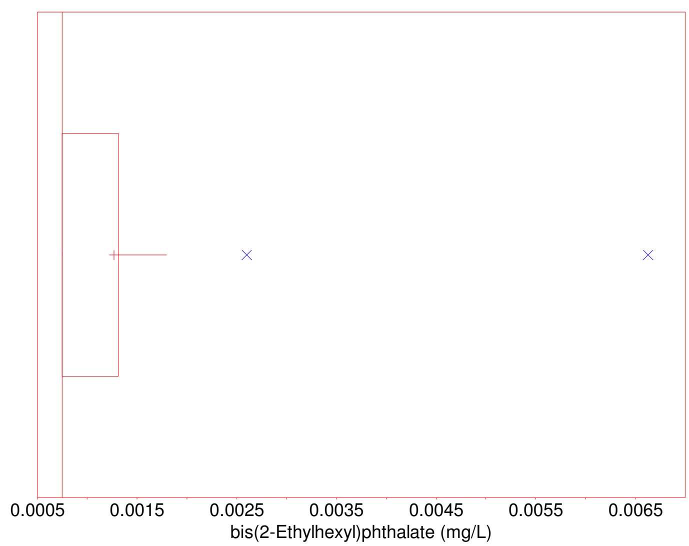
Data Plots for bis(2-Ethylhexyl)phthalate
Graphical displays of the data are shown below.

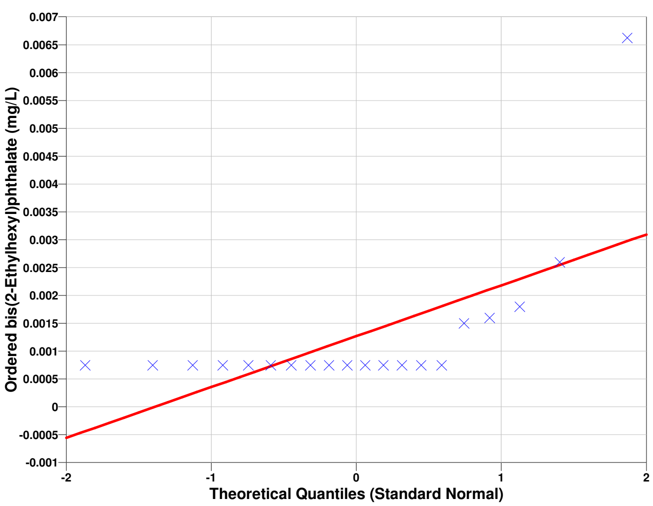
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through

2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for bis(2-Ethylhexyl)phthalate
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.4461
Shapiro-Wilk 5% Critical Value	0.905

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.001793
95% Non-Parametric (Chebyshev) UCL	0.002591

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.002591) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=20 data,
AL is the action level or threshold (7.33259),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=19 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-11.652	1.7291	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
19	14	Reject

Data Analysis for Cyclohexane
The following data points were entered by the user for analysis.

Cyclohexane (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.000265	0.000265	0.000265	0.000265	0.000265	0.000265	0.000265	0.000265	0.000265	0.000265
10	0.000265	0.000265	0.000265	0.000265	0.000265	0.000265	0.00058	0.00068	0.00076	0.0323

SUMMARY STATISTICS for Cyclohexane	
n	20
Min	0.000265
Max	0.0323
Range	0.032035
Mean	0.001928
Median	0.000265
Variance	5.1129e-005
StdDev	0.0071504
Std Error	0.0015989
Skewness	4.4688
Interquartile Range	0

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.000265	0.000265	0.000265	0.000265	0.000265	0.000265	0.000752	0.03072	0.0323

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Cyclohexane	
Dixon Test Statistic	0
Dixon 5% Critical Value	0.45

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.000265 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)

Shapiro-Wilk Test Statistic	0.2556
Shapiro-Wilk 5% Critical Value	0.901

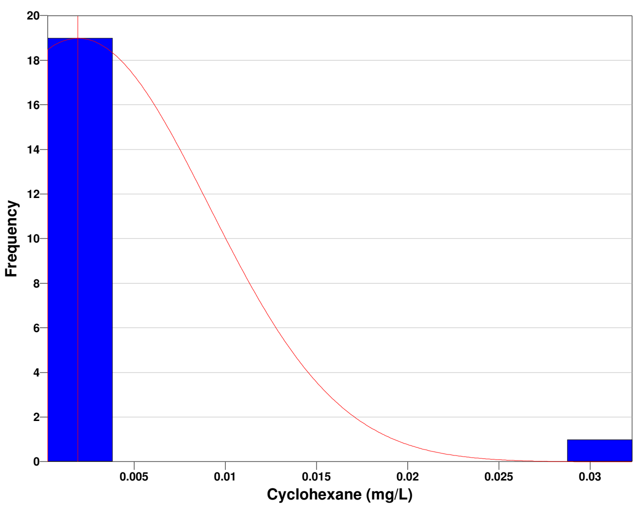
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.000265, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

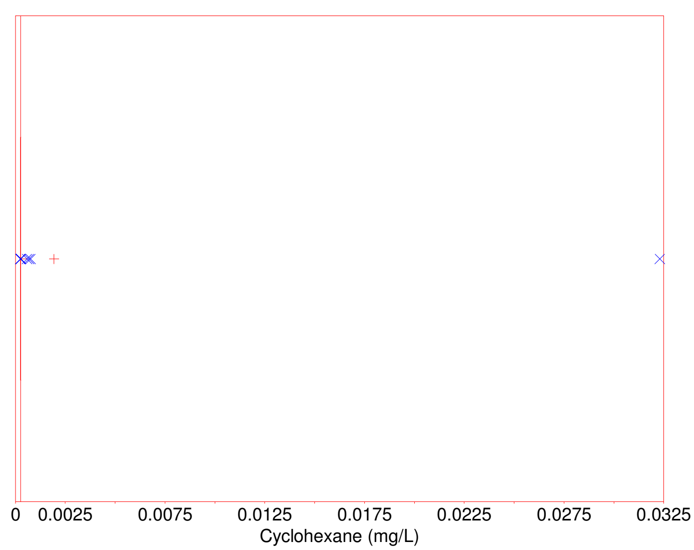
Data Plots for Cyclohexane
Graphical displays of the data are shown below.

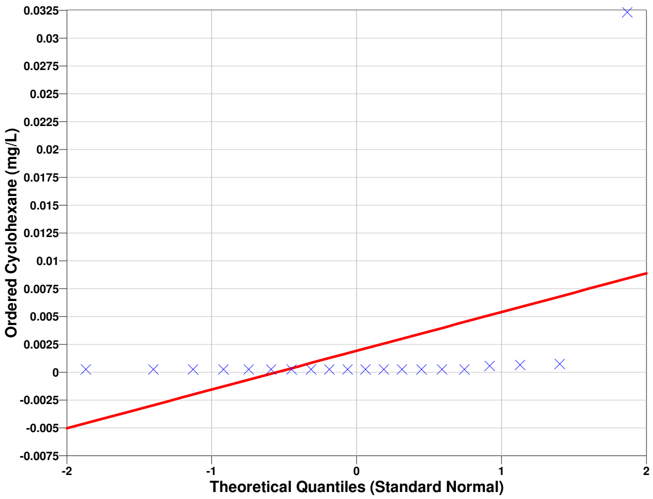
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Cyclohexane

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.2472
Shapiro-Wilk 5% Critical Value	0.905

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.004693
95% Non-Parametric (Chebyshev) UCL	0.008897

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.008897) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test

A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where

x is the sample mean of the n=20 data,

AL is the action level or threshold (7.33259),

SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=19 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-7825.7	1.7291	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
20	14	Reject

Data Analysis for Ethylbenzene
The following data points were entered by the user for analysis.

Ethylbenzene (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.000225	0.000225	0.000225	0.000225	0.000225	0.000225	0.000225	0.000225	0.000225	0.000225
10	0.000225	0.00024	0.00024	0.00024	0.00024	0.00058	0.002	0.0034	0.0038	0.008

SUMMARY STATISTICS for Ethylbenzene								
n				20				
Min				0.000225				
Max				0.008				
Range				0.007775				
Mean				0.0010607				
Median				0.000225				
Variance				3.8221e-006				
StdDev				0.001955				
Std Error				0.00043716				
Skewness				2.8142				
Interquartile Range				0.00027				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.000225	0.000225	0.000225	0.000225	0.000225	0.000495	0.00376	0.00779	0.008

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any

values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Ethylbenzene	
Dixon Test Statistic	0
Dixon 5% Critical Value	0.45

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.000225 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5236
Shapiro-Wilk 5% Critical Value	0.901

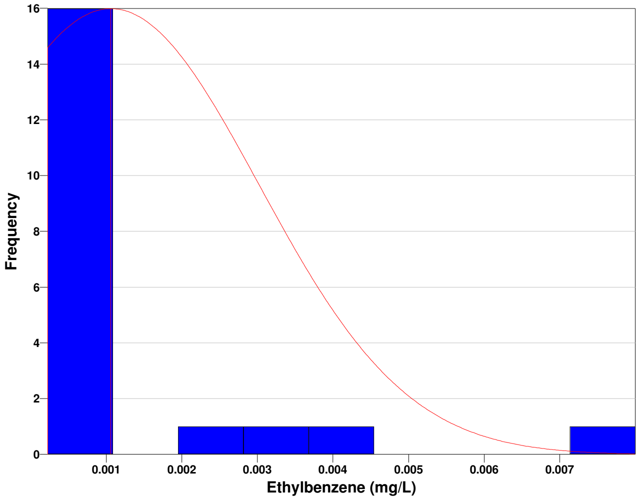
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.000225, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

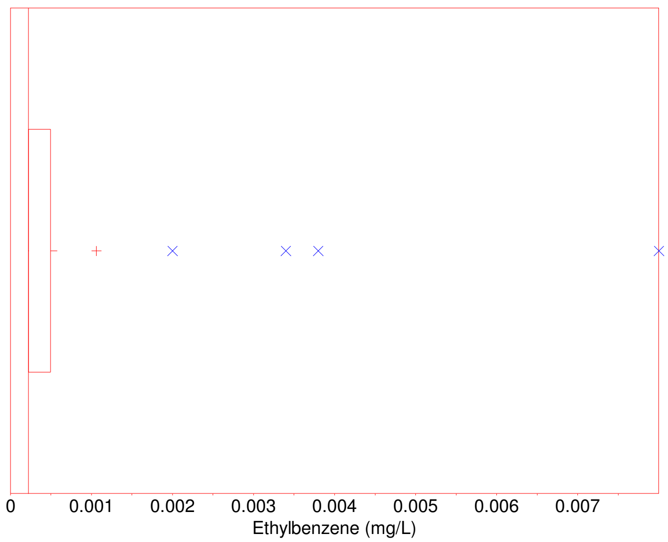
Data Plots for Ethylbenzene
Graphical displays of the data are shown below.

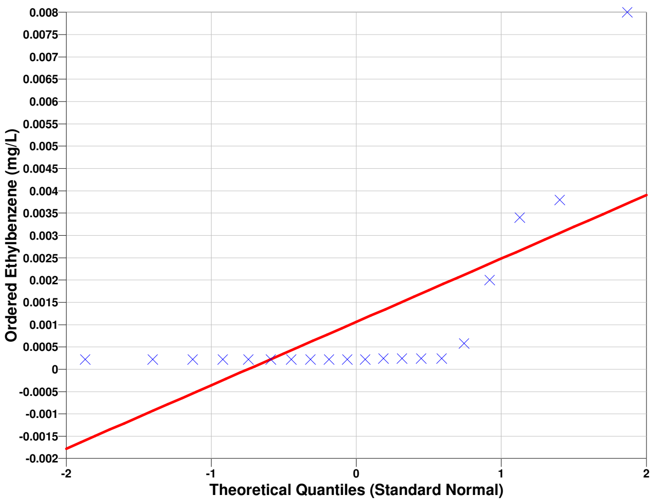
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Ethylbenzene

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5087
Shapiro-Wilk 5% Critical Value	0.905

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.001817

95% Non-Parametric (Chebyshev) UCL	0.002966

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.002966) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=20 data,
AL is the action level or threshold (7.33259),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=19 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1598.8	1.7291	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
20	14	Reject

Data Analysis for Lead
The following data points were entered by the user for analysis.

Lead (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014
10	0.0014	0.0014	0.0014	0.0014	0.0044	0.0057	0.0072	0.0087	0.01	0.0195

SUMMARY STATISTICS for Lead	
n	20
Min	0.0014
Max	0.0195
Range	0.0181
Mean	0.003755
Median	0.0014

Variance				2.1319e-005				
StdDev				0.0046173				
Std Error				0.0010325				
Skewness				2.4555				
Interquartile Range				0.003975				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0014	0.0014	0.0014	0.0014	0.0014	0.005375	0.00987	0.01902	0.0195

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Lead	
Dixon Test Statistic	0
Dixon 5% Critical Value	0.45

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.0014 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6121
Shapiro-Wilk 5% Critical Value	0.901

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.0014, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

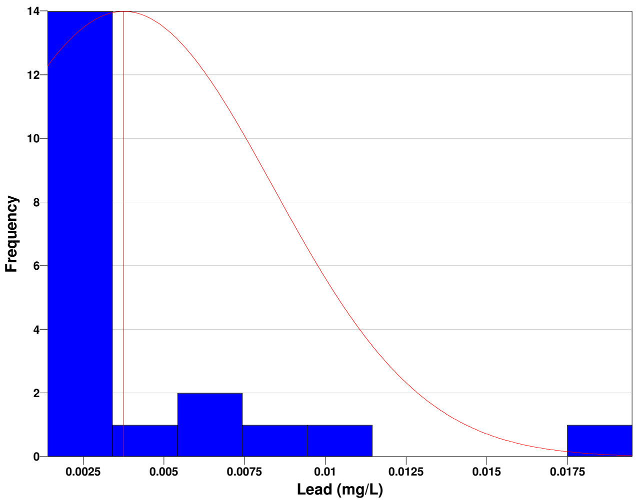
Data Plots for Lead
Graphical displays of the data are shown below.

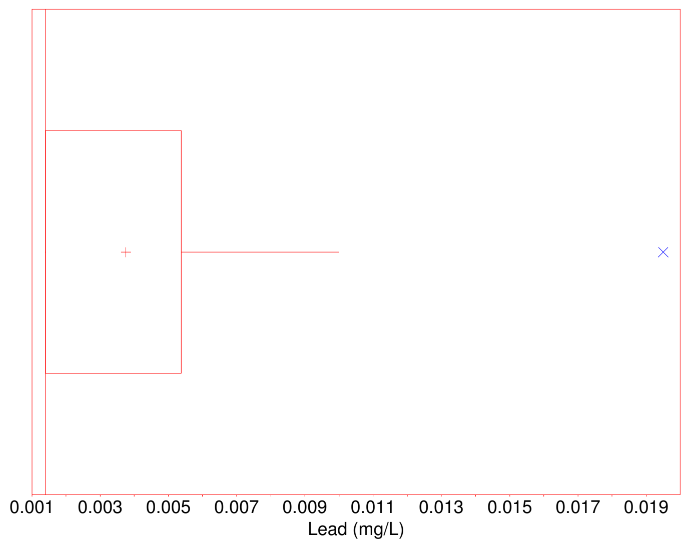
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

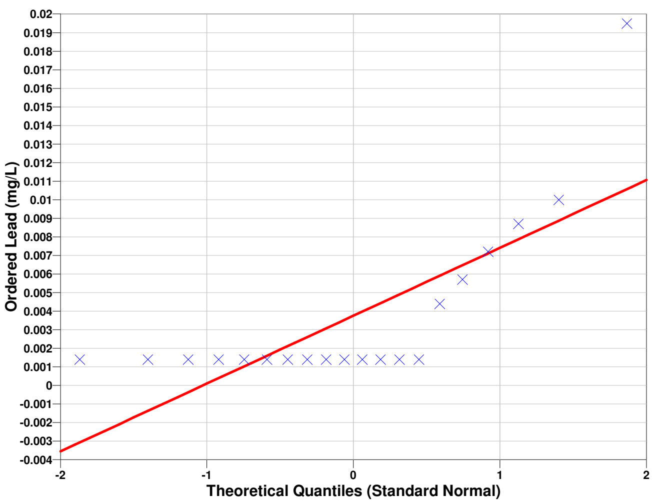
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends

to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Lead
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5959
Shapiro-Wilk 5% Critical Value	0.905

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.00554
95% Non-Parametric (Chebyshev) UCL	0.008255

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.008255) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=20 data,
AL is the action level or threshold (7.33259),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=19 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-10.891	1.7291	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
19	14	Reject

Data Analysis for Manganese
The following data points were entered by the user for analysis.

Manganese (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.11	0.111	0.118	0.139	0.146	0.17	0.276	0.324	0.3525	0.394
10	0.4525	0.746	0.776	0.826	0.968	0.994	1.01	2.14	2.15	4.12

SUMMARY STATISTICS for Manganese								
n	20							
Min	0.11							
Max	4.12							
Range	4.01							
Mean	0.81615							
Median	0.42325							
Variance	0.96915							
StdDev	0.98446							
Std Error	0.22013							
Skewness	2.3505							
Interquartile Range	0.8355							
Percentiles								
1%	5%	10%	25%	50%	75%	90%	95%	99%
0.11	0.1101	0.1117	0.152	0.4233	0.9875	2.149	4.021	4.12

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Manganese	
Dixon Test Statistic	0.0039409
Dixon 5% Critical Value	0.45

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.11 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7169
Shapiro-Wilk 5% Critical Value	0.901

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.11, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

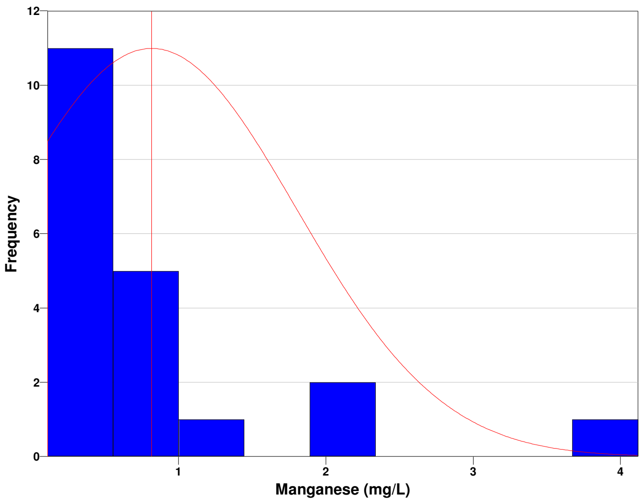
Data Plots for Manganese
Graphical displays of the data are shown below.

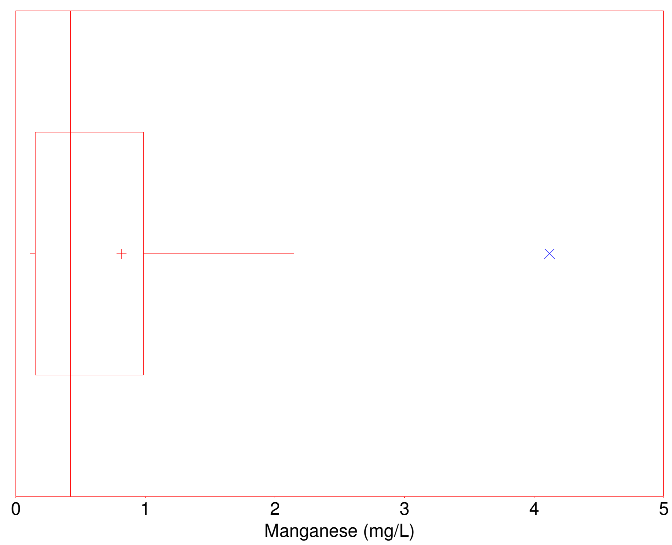
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

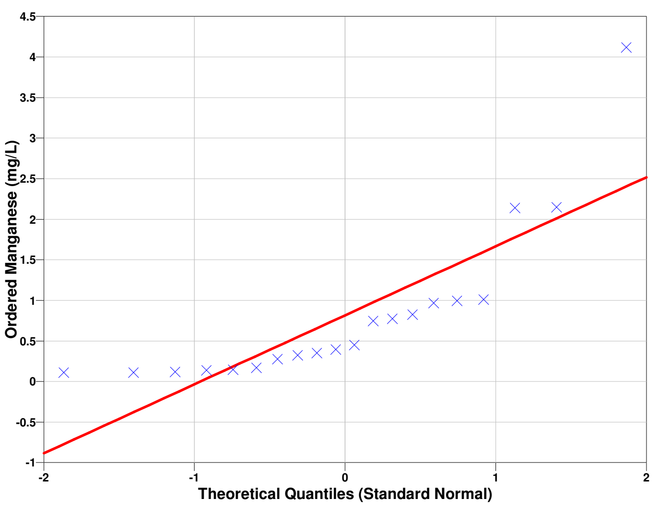
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Manganese
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.707
Shapiro-Wilk 5% Critical Value	0.905

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	1.197
95% Non-Parametric (Chebyshev) UCL	1.776

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (1.776) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=20 data,
AL is the action level or threshold (7.33259),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=19 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.511	1.7291	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
17	14	Reject

Data Analysis for Naphthalene
The following data points were entered by the user for analysis.

Naphthalene (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075
10	0.00075	0.00075	0.00075	0.00075	0.00075	0.0021	0.0053	0.0256	0.0273	0.163

SUMMARY STATISTICS for Naphthalene								
n	20							
Min	0.00075							
Max	0.163							
Range	0.16225							
Mean	0.011728							
Median	0.00075							
Variance	0.0013295							
StdDev	0.036462							
Std Error	0.0081531							
Skewness	4.1585							
Interquartile Range	0.0010125							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00075	0.00075	0.00075	0.00075	0.00075	0.001763	0.02713	0.1562	0.163

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Naphthalene	
Dixon Test Statistic	0
Dixon 5% Critical Value	0.45

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.00075 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.3524
Shapiro-Wilk 5% Critical Value	0.901

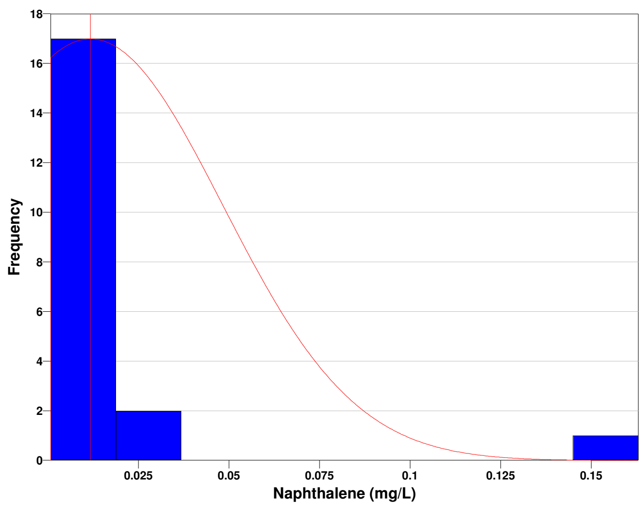
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.00075, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

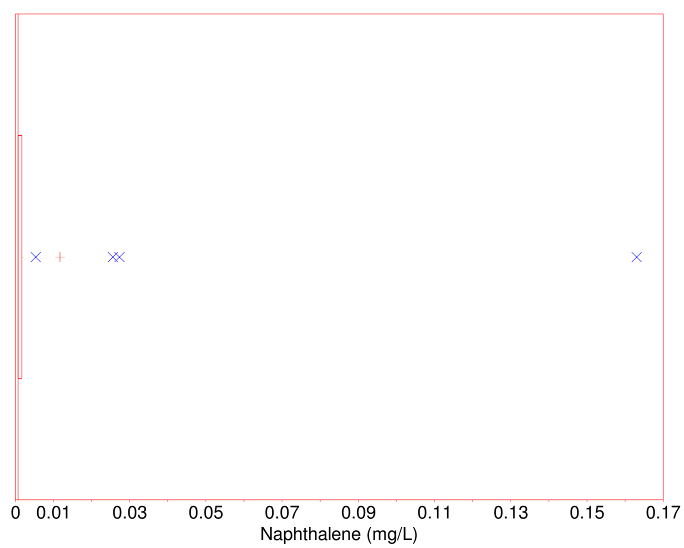
Data Plots for Naphthalene
Graphical displays of the data are shown below.

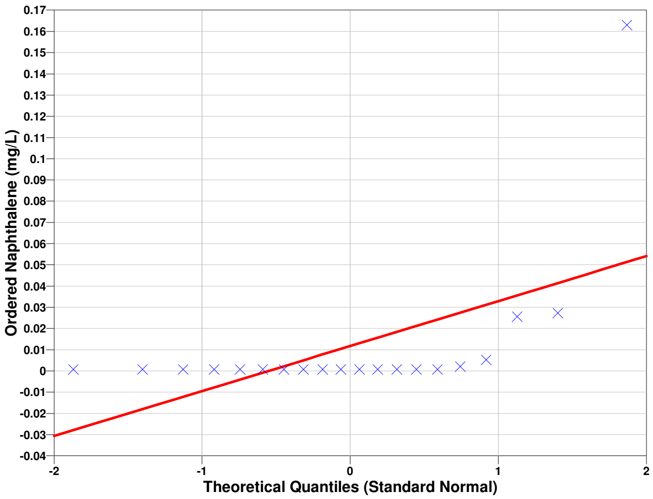
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Naphthalene

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.3416
Shapiro-Wilk 5% Critical Value	0.905

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.02583
95% Non-Parametric (Chebyshev) UCL	0.04727

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.04727) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test

A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where

x is the sample mean of the n=20 data,

AL is the action level or threshold (7.33259),

SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=19 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
0.6776	1.7291	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
17	14	Reject

Data Analysis for Nickel
The following data points were entered by the user for analysis.

Nickel (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013
10	0.0013	0.0013	0.0029	0.0032	0.0035	0.00435	0.0063	0.0067	0.0099	0.0516

SUMMARY STATISTICS for Nickel								
n	20							
Min	0.0013							
Max	0.0516							
Range	0.0503							
Mean	0.0052025							
Median	0.0013							
Variance	0.00012494							
StdDev	0.011178							
Std Error	0.0024994							
Skewness	4.1559							
Interquartile Range	0.0028375							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0013	0.0013	0.0013	0.0013	0.0013	0.004137	0.00958	0.04951	0.0516

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any

values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Nickel	
Dixon Test Statistic	0
Dixon 5% Critical Value	0.45

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.0013 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.3927
Shapiro-Wilk 5% Critical Value	0.901

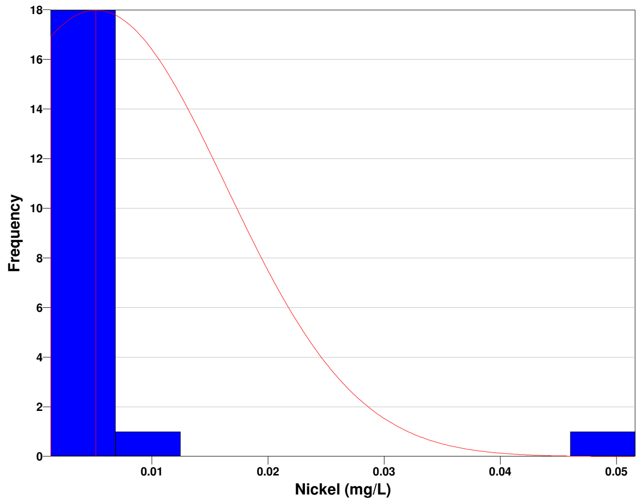
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.0013, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

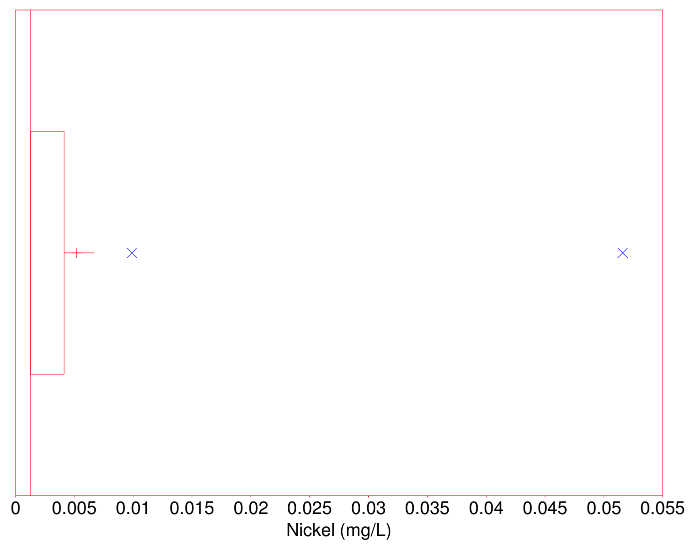
Data Plots for Nickel
Graphical displays of the data are shown below.

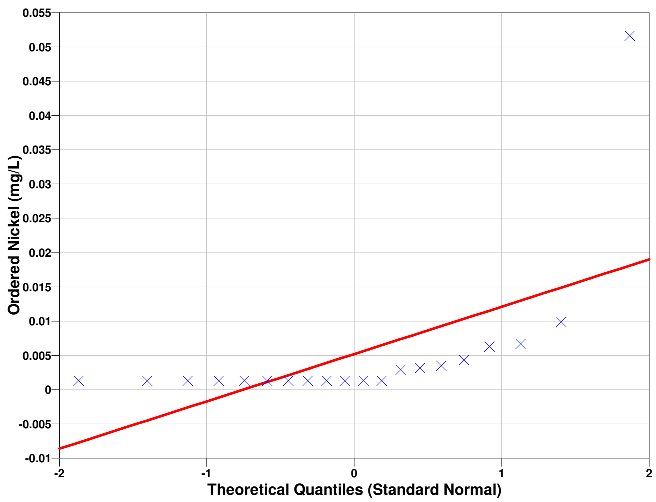
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Nickel
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.382
Shapiro-Wilk 5% Critical Value	0.905

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.009524

95% Non-Parametric (Chebyshev) UCL	0.0161

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.0161) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=20 data,
AL is the action level or threshold (7.33259),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=19 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-193.5	1.7291	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
20	14	Reject

Data Analysis for Thallium
The following data points were entered by the user for analysis.

Thallium (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00135	0.00135	0.00135	0.00135	0.00135	0.00135	0.00135	0.002225	0.0035	0.0035
10	0.0037	0.0041	0.0042	0.0048	0.0048	0.0048	0.0051	0.0051	0.0062	0.0067

SUMMARY STATISTICS for Thallium	
n	20
Min	0.00135
Max	0.0067
Range	0.00535
Mean	0.0034087
Median	0.0036

Variance				3.2856e-006				
StdDev				0.0018126				
Std Error				0.00040532				
Skewness				0.13024				
Interquartile Range				0.00345				
Percentiles								
1%	5%	10%	25%	50%	75%	90%	95%	99%
0.00135	0.00135	0.00135	0.00135	0.0036	0.0048	0.00609	0.006675	0.0067

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Thallium	
Dixon Test Statistic	0
Dixon 5% Critical Value	0.45

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.00135 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8889
Shapiro-Wilk 5% Critical Value	0.901

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.00135, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

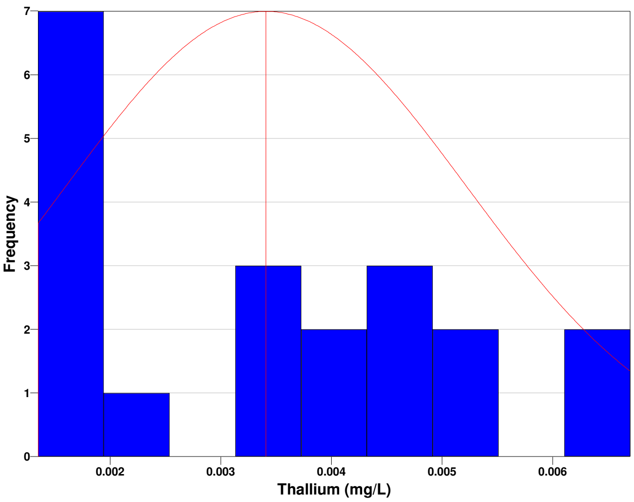
Data Plots for Thallium
Graphical displays of the data are shown below.

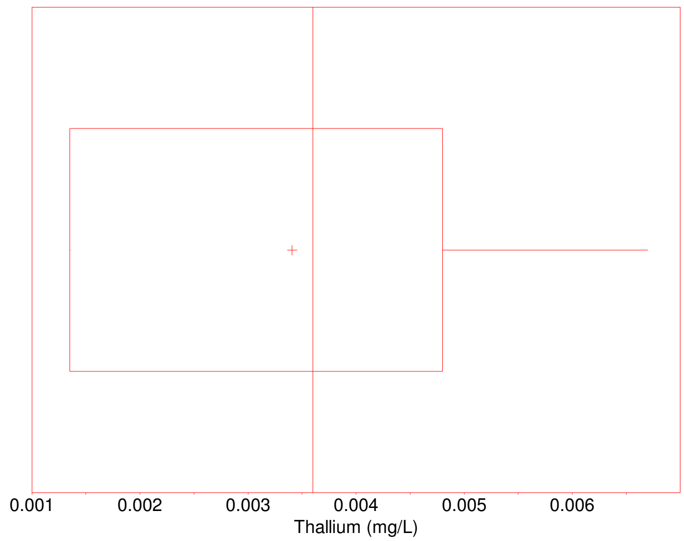
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

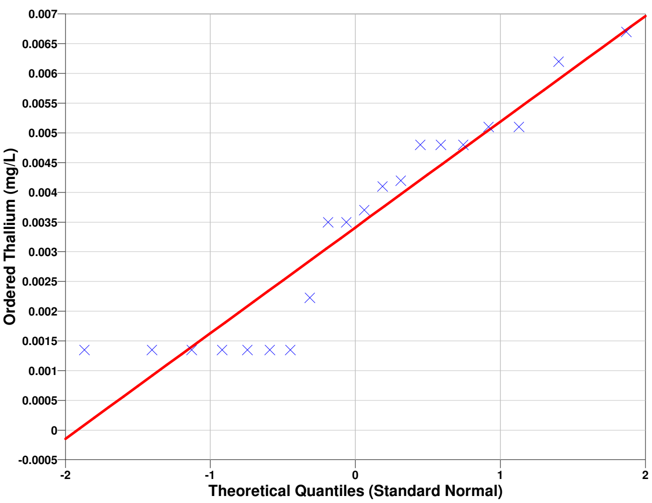
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends

to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Thallium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8757
Shapiro-Wilk 5% Critical Value	0.905

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.00411
95% Non-Parametric (Chebyshev) UCL	0.005175

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.005175) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=20 data,
AL is the action level or threshold (7.33259),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=19 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
3.4757	1.7291	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	14	Cannot Reject
Note: There may not be enough data to reject the null hypothesis (and conclude site is clean) with 95% confidence using the MARSSIM sign test.		

Data Analysis for Vanadium
The following data points were entered by the user for analysis.

Vanadium (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

0	0.00047	0.00047	0.00047	0.00047	0.00047	0.00047	0.0011	0.0011	0.0011	0.0012
10	0.0013	0.0015	0.0018	0.0019	0.0021	0.00215	0.0025	0.0033	0.0136	0.01665

SUMMARY STATISTICS for Vanadium								
n	20							
Min	0.00047							
Max	0.01665							
Range	0.01618							
Mean	0.002706							
Median	0.00125							
Variance	1.89e-005							
StdDev	0.0043474							
Std Error	0.0009721							
Skewness	2.7866							
Interquartile Range	0.0016675							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00047	0.00047	0.00047	0.00047	0.00125	0.002138	0.01257	0.0165	0.01665

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Vanadium	
Dixon Test Statistic	0
Dixon 5% Critical Value	0.45

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.00047 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5301
Shapiro-Wilk 5% Critical Value	0.901

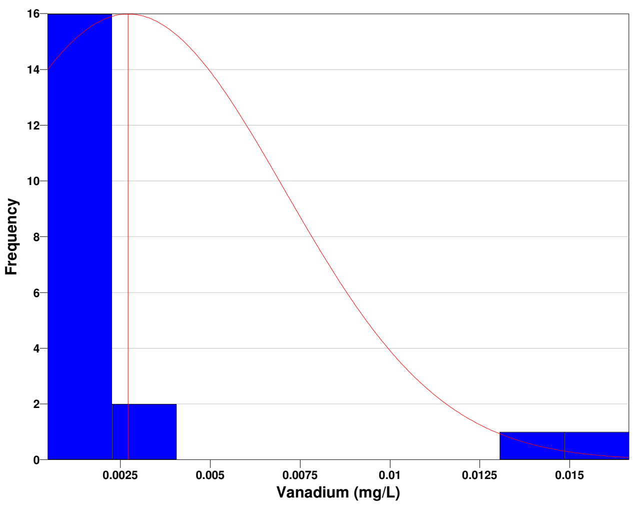
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.00047, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

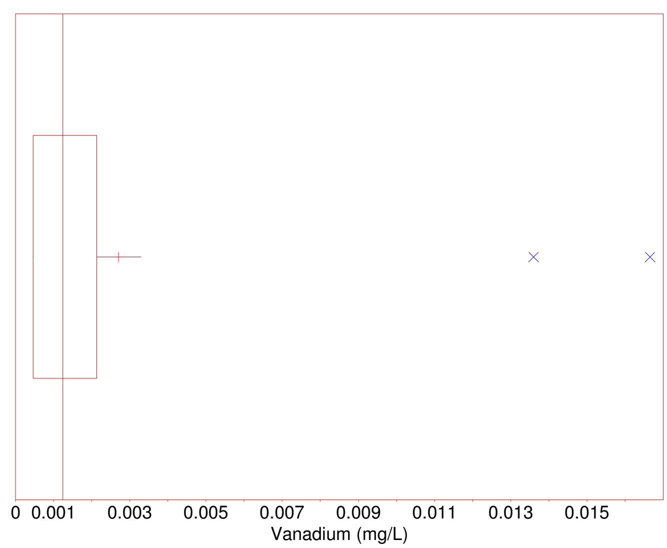
Data Plots for Vanadium
Graphical displays of the data are shown below.

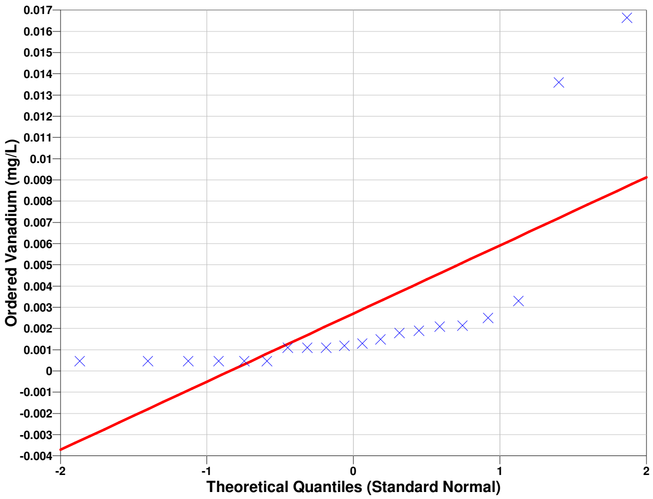
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Vanadium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5207
Shapiro-Wilk 5% Critical Value	0.905

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.004387
95% Non-Parametric (Chebyshev) UCL	0.006943

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.006943) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=20 data,
AL is the action level or threshold (7.33259),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=19 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-173.22	1.7291	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
20	14	Reject

Data Analysis for Zinc
The following data points were entered by the user for analysis.

Zinc (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0123	0.0127	0.0128	0.0133	0.014	0.0143	0.0151	0.0155	0.0155	0.0156
10	0.0165	0.01665	0.01695	0.0215	0.0216	0.0484	0.0495	0.0552	0.0564	0.196

SUMMARY STATISTICS for Zinc	
n	20
Min	0.0123
Max	0.196
Range	0.1837
Mean	0.03199
Median	0.01605
Variance	0.0017232
StdDev	0.041511
Std Error	0.0092823
Skewness	3.5788
Interquartile Range	0.027625

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0123	0.01232	0.01271	0.01408	0.01605	0.0417	0.05628	0.189	0.196

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any

values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Zinc	
Dixon Test Statistic	0.011655
Dixon 5% Critical Value	0.45

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.0123 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5017
Shapiro-Wilk 5% Critical Value	0.901

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.0123, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

Data Plots for Zinc
Graphical displays of the data are shown below.

The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

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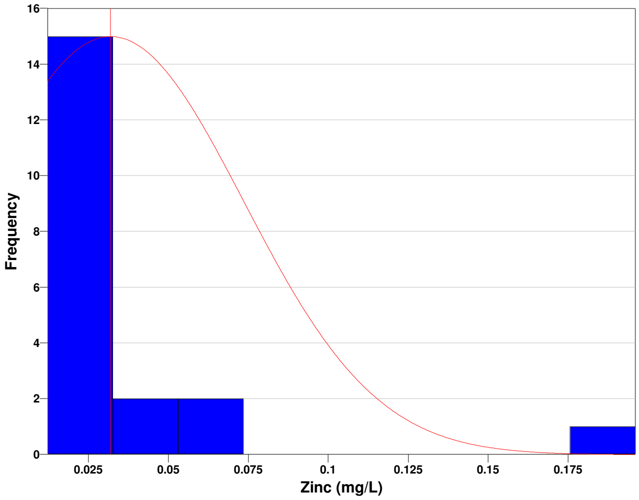
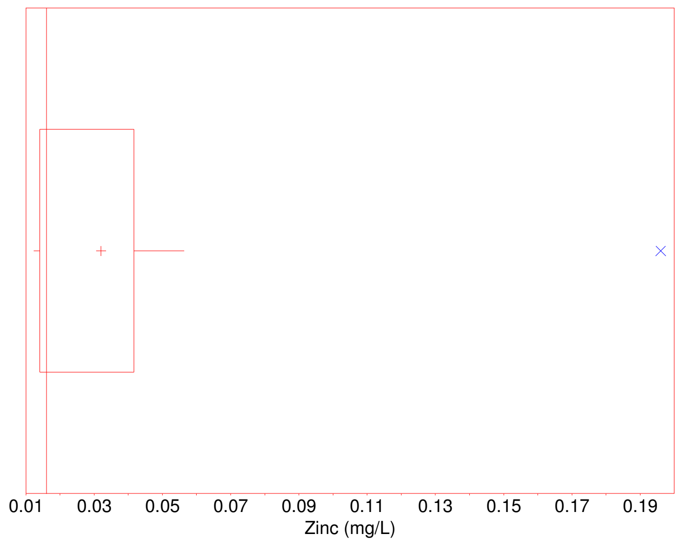
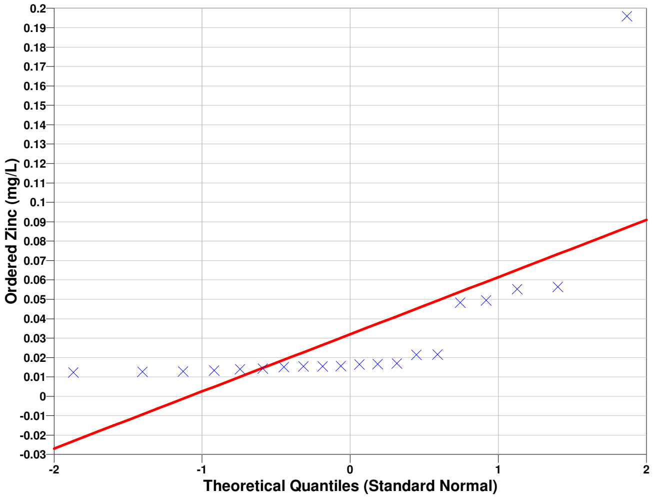
The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Zinc
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.4927
Shapiro-Wilk 5% Critical Value	0.905

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.04804

95% Non-Parametric (Chebyshev) UCL	0.07245

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.07245) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=20 data,
AL is the action level or threshold (7.33259),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=19 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-786.51	1.7291	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
20	14	Reject

Data Analysis for 1-Methylnaphthalene
The following data points were entered by the user for analysis.

1-Methylnaphthalene (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00085	0.00085	0.00085	0.00085	0.00085	0.00085	0.00085	0.00085	0.00085	0.00085
10	0.00085	0.00085	0.00085	0.00085	0.00085	0.0009	0.002	0.0109	0.0155	0.0647

SUMMARY STATISTICS for 1-Methylnaphthalene	
n	20
Min	0.00085
Max	0.0647
Range	0.06385
Mean	0.0053375
Median	0.00085

Variance				0.00021005				
StdDev				0.014493				
Std Error				0.0032408				
Skewness				4.0134				
Interquartile Range				3.75e-005				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00085	0.00085	0.00085	0.00085	0.00085	0.0008875	0.01504	0.06224	0.0647

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for 1-Methylnaphthalene	
Dixon Test Statistic	0
Dixon 5% Critical Value	0.45

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.00085 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.3686
Shapiro-Wilk 5% Critical Value	0.901

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.00085, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

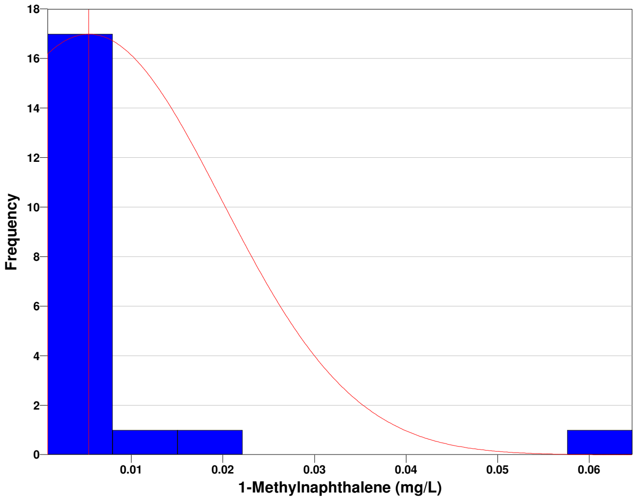
Data Plots for 1-Methylnaphthalene
Graphical displays of the data are shown below.

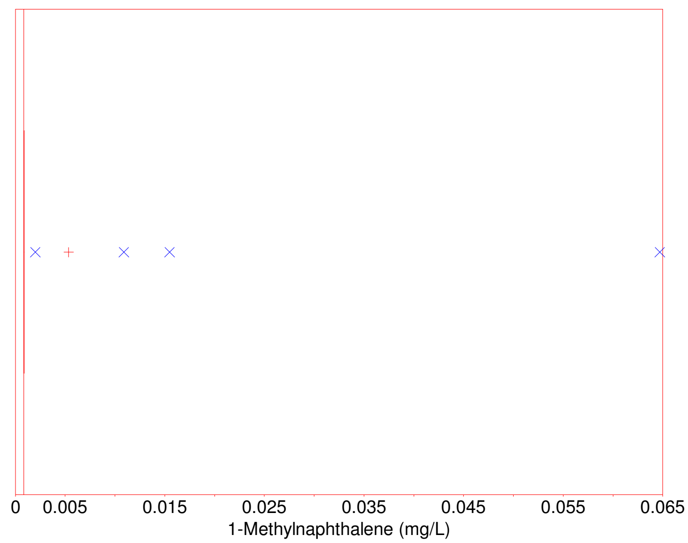
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

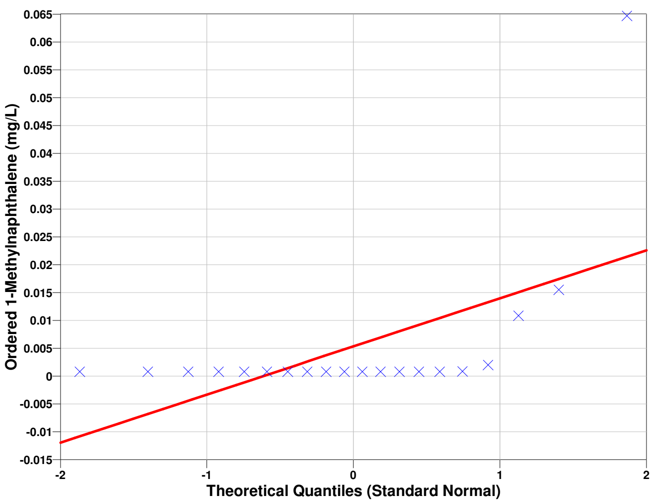
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends

to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for 1-Methylnaphthalene
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.3572
Shapiro-Wilk 5% Critical Value	0.905

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.01094
95% Non-Parametric (Chebyshev) UCL	0.01946

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.01946) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=20 data,
AL is the action level or threshold (7.33259),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=19 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-526.29	1.7291	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
20	14	Reject

This report was automatically produced* by Visual Sample Plan (VSP) software version 5.3.1.
Software and documentation available at http://dqo.pnl.gov/vsp

* - The report contents may have been modified or reformatted by end-user of software.

Appendix C

VSP Reports of Calculated Minimum Sample Quantity
Report 11
Area of Concern – 3
Minimum Sample Quantity Calculation for Surface Soil using Human Health Benchmarks and Delta Method 1

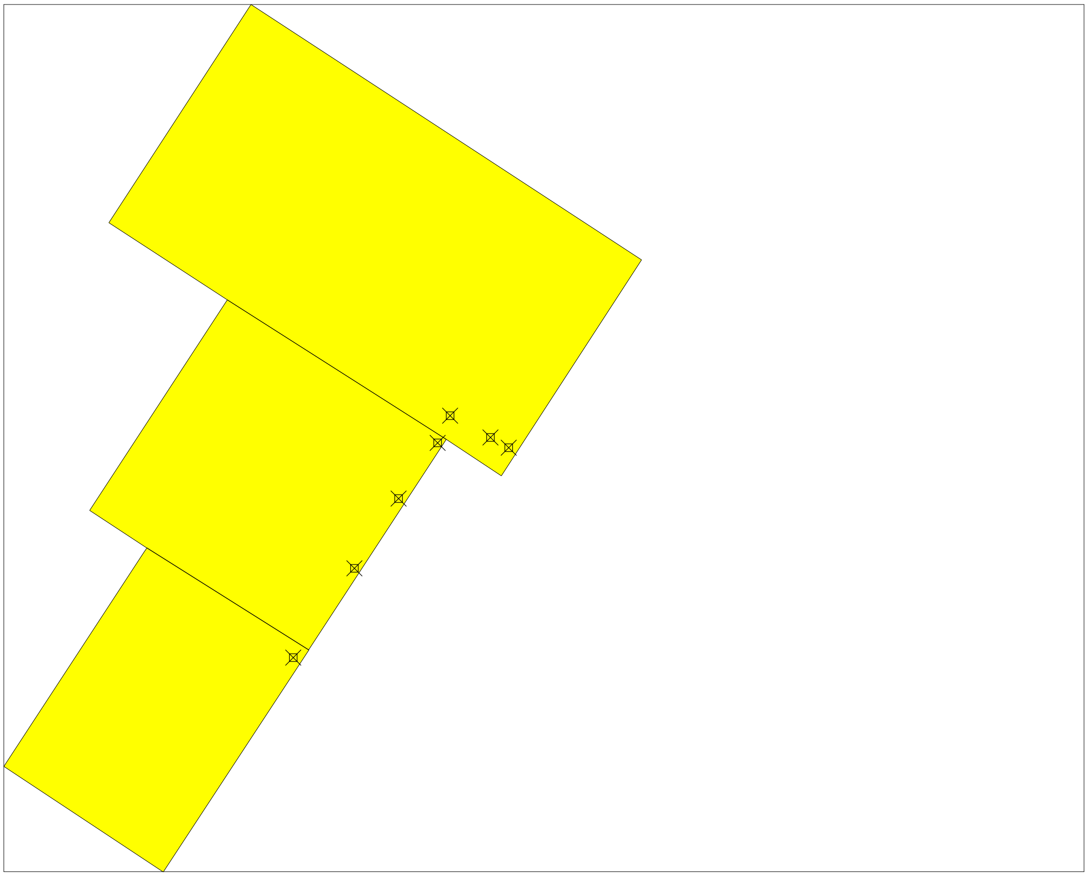
Random sampling locations for comparing a mean with a fixed threshold (parametric)

Summary
This report summarizes the sampling design, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design for Arsenic, the driving analyte (the analyte which required the largest number of samples). A figure that shows sampling locations in the field and a table that lists sampling location coordinates are also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean to a fixed threshold
Type of Sampling Design	Parametric
Sample Placement (Location) in the Field	Simple random sampling
Working (Null) Hypothesis	The mean value at the site exceeds the threshold
Formula for calculating number of sampling locations	Student's t-test
Calculated total number of samples	7
Number of samples on map [a]	7
Number of selected sample areas [b]	1
Specified sampling area [c]	602117.04 m^2
Total cost of sampling [d]	$4,500.00

[a] This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[d] Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.



Area: Area 1					
X Coord	Y Coord	Label	Value	Type	Historical
680077.3540	3083115.5330	J-50S		Manual	T
680141.8730	3083080.8800	J-52S		Manual	T
680170.5600	3083064.6740	J-53S		Manual	T
679924.8150	3082872.3490	J-47S		Manual	T
679994.9690	3082983.5100	J-48S		Manual	T
680057.6580	3083072.0750	J-49S		Manual	T
679827.1150	3082729.7460	J-51S		Manual	T

Primary Sampling Objective
The primary purpose of sampling at this site is to compare a mean value of a site with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the mean value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the mean value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative hypothesis, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach
A parametric random sampling approach was used to determine the number of samples and to specify sampling locations. A parametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that parametric assumptions are reasonable. These assumptions will be examined in post-sampling data analysis.

Both parametric and non-parametric approaches rely on assumptions about the population. However, non-parametric approaches typically require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than the number of samples required by non-parametric approaches.

Locating the sample points randomly provides data that are separated by many distances, whereas systematic samples are all equidistant apart. Therefore, random sampling provides more information about the spatial structure of the potential contamination than systematic sampling does. As with systematic sampling, random sampling also provides information regarding the mean value, but there is the possibility that areas of the site will not be represented with the same frequency as if uniform grid sampling were performed.

Number of Total Samples: Calculation Equation and Inputs
The equation used to calculate the number of samples is based on a Student's t-test. For this site, the null hypothesis is rejected in favor of the alternative hypothesis if the sample mean is sufficiently smaller than the threshold. The number of samples to collect is calculated so that 1) there will be a high probability (1-β) of rejecting the null hypothesis if the alternative hypothesis is true and 2) a low probability (α) of rejecting the null hypothesis if the null hypothesis is true.

The formula used to calculate the number of samples is:

$$n = \frac{S^2}{\Delta^2}\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2 + 0.5Z_{1-\alpha}^2$$

where
n is the number of samples,
S is the estimated standard deviation of the measured values including analytical error,
Δ is the width of the gray region,
α is the acceptable probability of incorrectly concluding the site mean is less than the threshold,
β is the acceptable probability of incorrectly concluding the site mean exceeds the threshold,
$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is 1-α,
$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is 1-β.

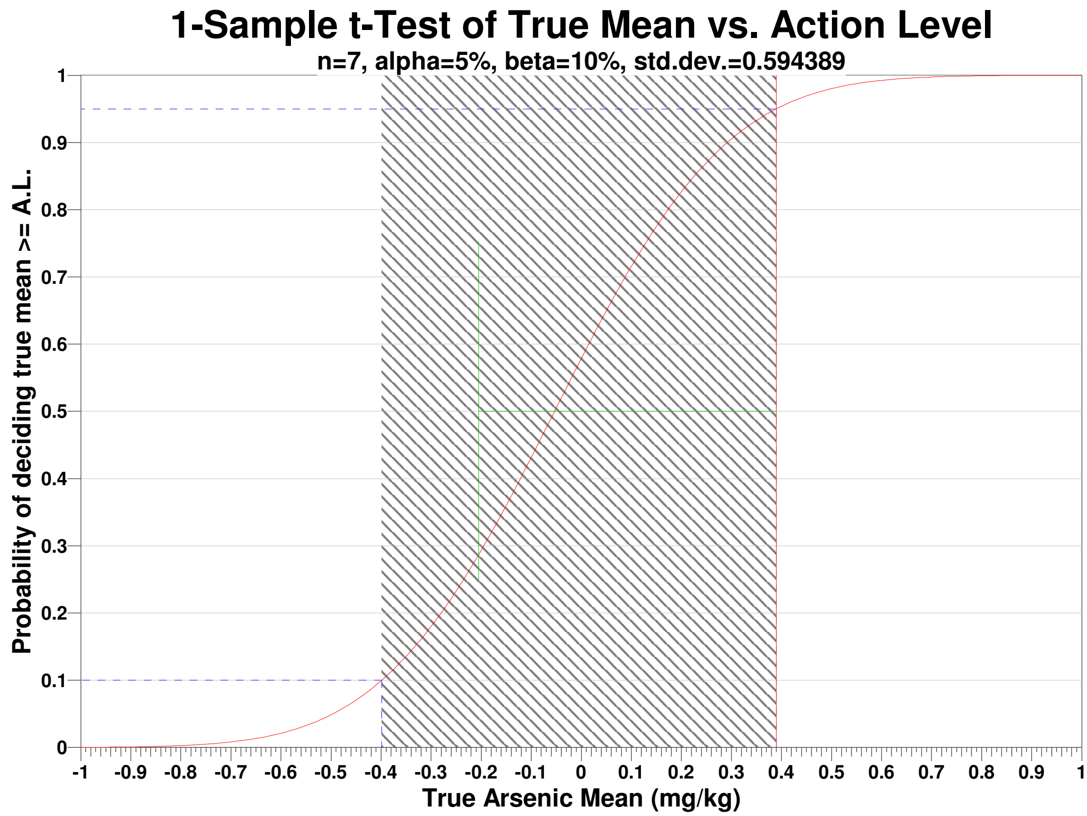
The values of these inputs that result in the calculated number of sampling locations are:

Analyte	n	Parameter					
		S	**Δ**	**α**	**β**	**$Z_{1-\alpha}$** [a]	**$Z_{1-\beta}$** [b]
New Location	2	0.1 mg/kg	10 mg/kg	0.05	0.1	1.64485	1.28155
Arsenic	7	0.594389 mg/kg	0.788233 mg/kg	0.05	0.1	1.64485	1.28155
Barium	2	209.832 mg/kg	7650.81 mg/kg	0.05	0.1	1.64485	1.28155
Beryllium	2	0.056614 mg/kg	37.3853 mg/kg	0.05	0.1	1.64485	1.28155
Chromium	2	1.43858 mg/kg	206.633 mg/kg	0.05	0.1	1.64485	1.28155
Cobalt	2	0.313741 mg/kg	901.915 mg/kg	0.05	0.1	1.64485	1.28155
Copper	2	0.80593 mg/kg	544.039 mg/kg	0.05	0.1	1.64485	1.28155
Lead	2	3.39053 mg/kg	393.329 mg/kg	0.05	0.1	1.64485	1.28155
Manganese	2	55.6166 mg/kg	3131.95 mg/kg	0.05	0.1	1.64485	1.28155
Mercury	2	0.00623534 mg/kg	2.07529 mg/kg	0.05	0.1	1.64485	1.28155
Nickel	2	0.606681 mg/kg	830.27 mg/kg	0.05	0.1	1.64485	1.28155
Vanadium	2	1.76136 mg/kg	285.086 mg/kg	0.05	0.1	1.64485	1.28155
Zinc	2	135.018 mg/kg	9803.59 mg/kg	0.05	0.1	1.64485	1.28155
Aluminum	4	1307.29 mg/kg	2494.73 mg/kg	0.05	0.1	1.64485	1.28155

[a] This value is automatically calculated by VSP based upon the user defined value of α.
[b] This value is automatically calculated by VSP based upon the user defined value of β.

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000) for Arsenic, the driving analyte. It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true mean values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at $1-\alpha$ on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at $1-\alpha$. If any of the inputs change, the number of samples that result in the correct curve changes.



Statistical Assumptions
The assumptions associated with the formulas for computing the number of samples are:

1. the sample mean is normally distributed (this happens if the data are roughly symmetric or the sample size is more than 30; for extremely skewed data sets, additional samples may be required for the sample mean to be normally distributed),
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected randomly.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the sample locations were selected using a random process.

Sensitivity Analysis
The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that μ > action level and alpha (%), probability of mistakenly concluding that μ < action level. The following table shows the results of this analysis.

Number of Samples						
AL=9921.47	α=5		α=10		α=15	
	s=270.036	s=135.018	s=270.036	s=135.018	s=270.036	s=135.018

LBGR=90	**β=5**	519836102	129959027	411358855	102839715	345333367	86333343
	β=10	411358855	102839715	315561561	78890391	258091177	64522795
	β=15	345333368	86333343	258091178	64522795	206392882	51598221
LBGR=80	**β=5**	129959027	32489758	102839715	25709930	86333343	21583336
	β=10	102839715	25709930	78890391	19722599	64522795	16130700
	β=15	86333343	21583337	64522795	16130700	51598221	12899556
LBGR=70	**β=5**	57759569	14439894	45706541	11426636	38370375	9592595
	β=10	45706541	11426637	35062397	8765600	28676798	7169200
	β=15	38370376	9592595	28676799	7169201	22932543	5733137

s = Standard Deviation
LBGR = Lower Bound of Gray Region (% of Action Level)
β = Beta (%), Probability of mistakenly concluding that μ > action level
α = Alpha (%), Probability of mistakenly concluding that μ < action level
AL = Action Level (Threshold)

Cost of Sampling
The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that are based on the number of samples collected and measured. Based on the numbers of samples determined above, the estimated total cost of sampling and analysis at this site is $4,500.00, which averages out to a per sample cost of $642.86. The following table summarizes the inputs and resulting cost estimates.

COST INFORMATION			
Cost Details	**Per Analysis**	**Per Sample**	**7 Samples**
Field collection costs		$100.00	$700.00
Analytical costs	$400.00	$400.00	$2,800.00
Sum of Field & Analytical costs		**$500.00**	**$3,500.00**
Fixed planning and validation costs			$1,000.00
Total cost			**$4,500.00**

Data Analysis for New Location
The following data points were entered by the user for analysis.

New Location (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0					

SUMMARY STATISTICS for New Location

n	75							
Min	0							
Max	0							
Range	0							
Mean	0							
Median	0							
Variance	0							
StdDev	0							
Std Error	0							
Skewness	-1.#IND							
Interquartile Range	0							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0	0	0	0	0	0	0	0	0

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for New Location			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	-1.#IO	3.285	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Lilliefors test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Lilliefors Test Statistic	0
Lilliefors 5% Critical Value	0.103

The calculated Lilliefors test statistic is less than the 5% Lilliefors critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do appear to follow a normal distribution at the 5% level of significance.

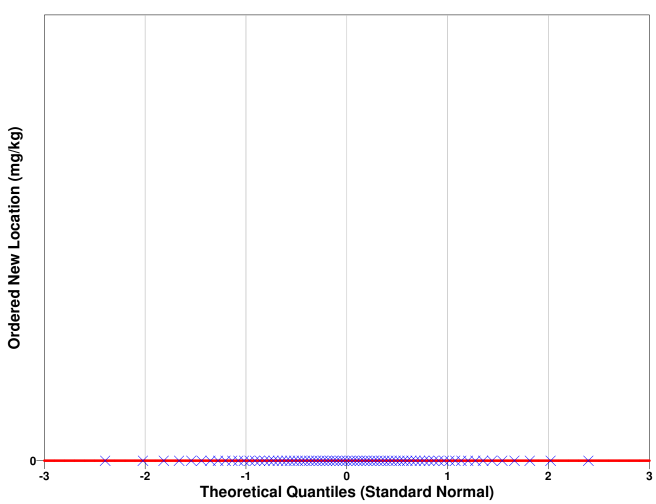
Data Plots for New Location
Graphical displays of the data are shown below.

The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The

sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.



For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for New Location

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution.

The Lilliefors test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Lilliefors Test Statistic	0
Lilliefors 5% Critical Value	0.1023

The calculated Lilliefors test statistic is less than the 5% Lilliefors critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0
95% Non-Parametric (Chebyshev) UCL	0

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=75 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=74 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.#IND	1.6657	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Data Analysis for Arsenic
The following data points were entered by the user for analysis.

Arsenic (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.72	0.96	0.965	1	1	1.1	2.5			

SUMMARY STATISTICS for Arsenic

n				7				
Min				0.72				
Max				2.5				
Range				1.78				
Mean				1.1779				
Median				1				
Variance				0.3533				
StdDev				0.59439				
Std Error				0.22466				
Skewness				2.4261				
Interquartile Range				0.14				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.72	0.72	0.72	0.96	1	1.1	2.5	2.5	2.5

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Arsenic	
Dixon Test Statistic	0.13483
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.72 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5638
Shapiro-Wilk 5% Critical Value	0.788

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.72, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

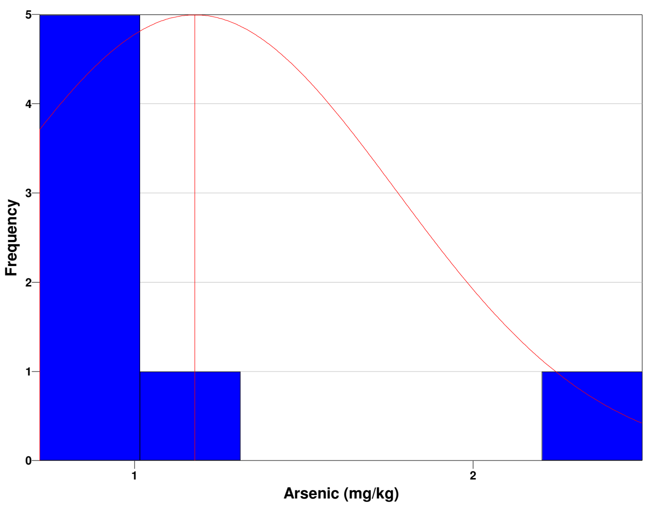
Data Plots for Arsenic
Graphical displays of the data are shown below.

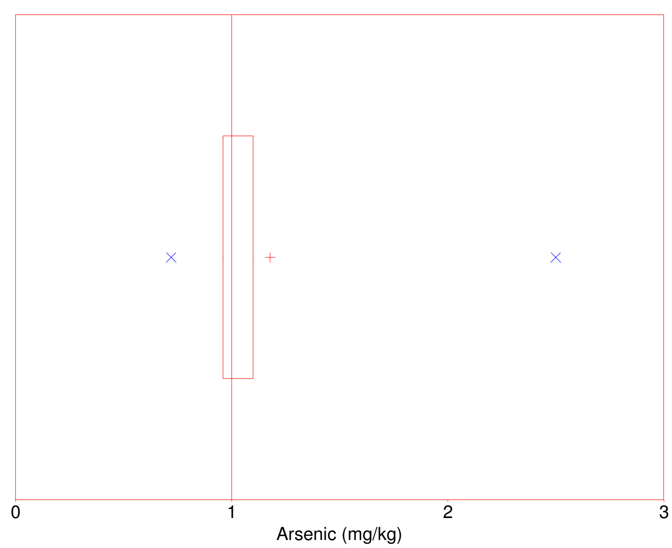
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The

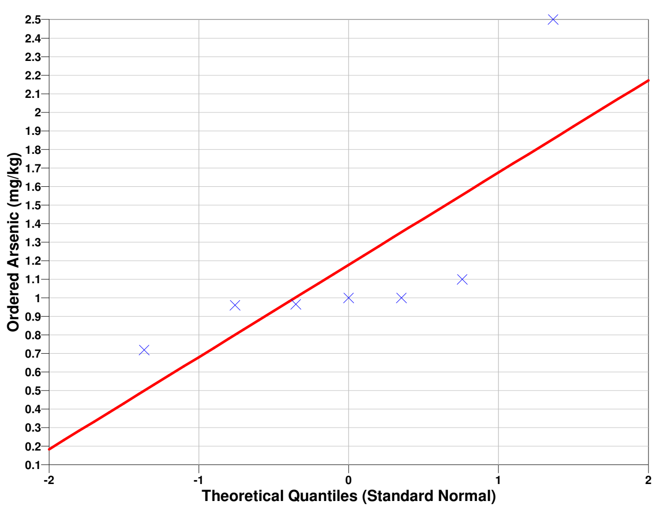
sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Arsenic
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution.

The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6313
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	1.614
95% Non-Parametric (Chebyshev) UCL	2.157

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (2.157) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
3.5086	1.9432	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
0	6	Cannot Reject
Note: There may not be enough data to reject the null hypothesis (and conclude site is clean) with 95% confidence using the MARSSIM sign test.		

Data Analysis for Barium
The following data points were entered by the user for analysis.

Barium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	16.6	37.9	74.4	139	206	224	630			

SUMMARY STATISTICS for Barium	
n	7
Min	16.6
Max	630
Range	613.4
Mean	189.7
Median	139
Variance	44030
StdDev	209.83
Std Error	79.309
Skewness	1.8956
Interquartile Range	186.1

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
16.6	16.6	16.6	37.9	139	224	630	630	630

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Barium	
Dixon Test Statistic	0.034724
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 16.6 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8015
Shapiro-Wilk 5% Critical Value	0.788

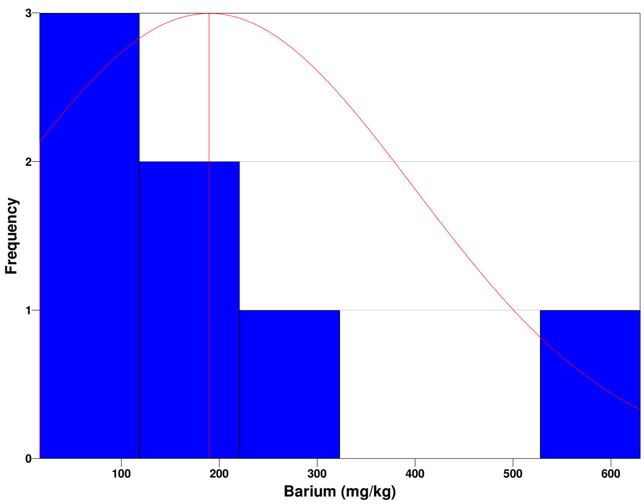
The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 16.6, do appear to follow a normal distribution at the 5% level of significance.

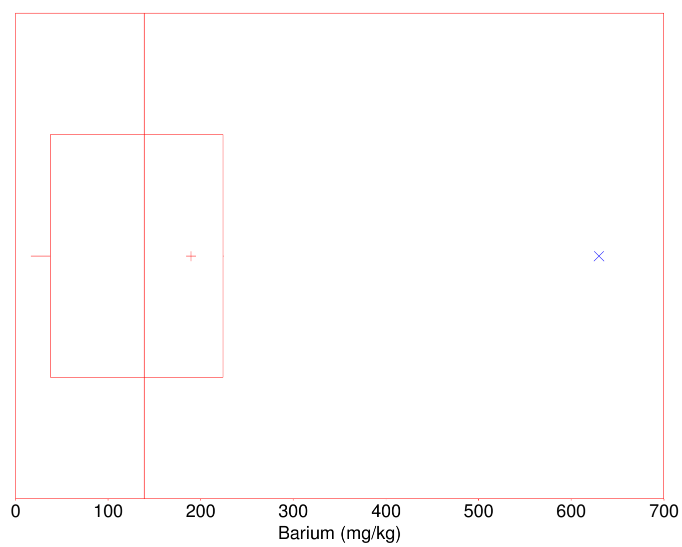
Data Plots for Barium
Graphical displays of the data are shown below.

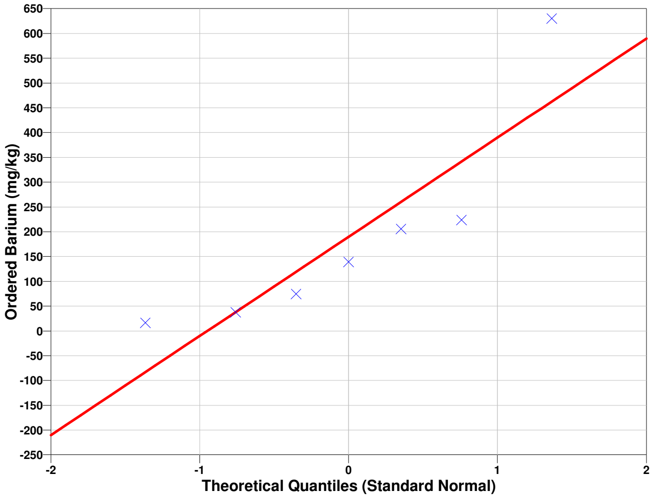
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Barium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7912
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	343.8
95% Non-Parametric (Chebyshev) UCL	535.4

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (535.4) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test

A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where

x is the sample mean of the n=7 data,

AL is the action level or threshold (9921.47),

SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-96.468	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Data Analysis for Beryllium
The following data points were entered by the user for analysis.

Beryllium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.074	0.15	0.17	0.18	0.21	0.23	0.24			

SUMMARY STATISTICS for Beryllium								
n	7							
Min	0.074							
Max	0.24							
Range	0.166							
Mean	0.17914							
Median	0.18							
Variance	0.0032051							
StdDev	0.056614							
Std Error	0.021398							
Skewness	-1.0307							
Interquartile Range	0.08							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.074	0.074	0.074	0.15	0.18	0.23	0.24	0.24	0.24

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible

explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Beryllium	
Dixon Test Statistic	0.45783
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.074 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9444
Shapiro-Wilk 5% Critical Value	0.788

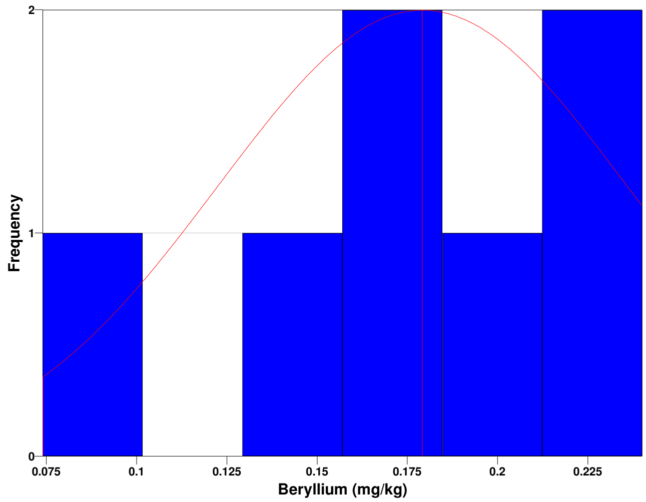
The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.074, do appear to follow a normal distribution at the 5% level of significance.

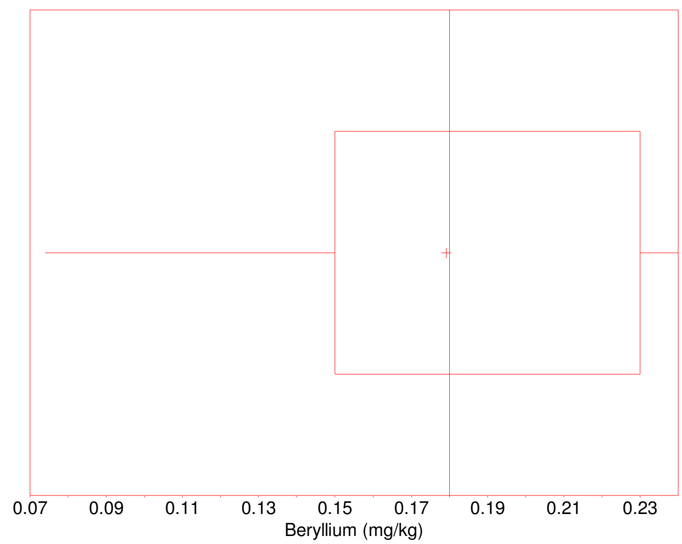
Data Plots for Beryllium
Graphical displays of the data are shown below.

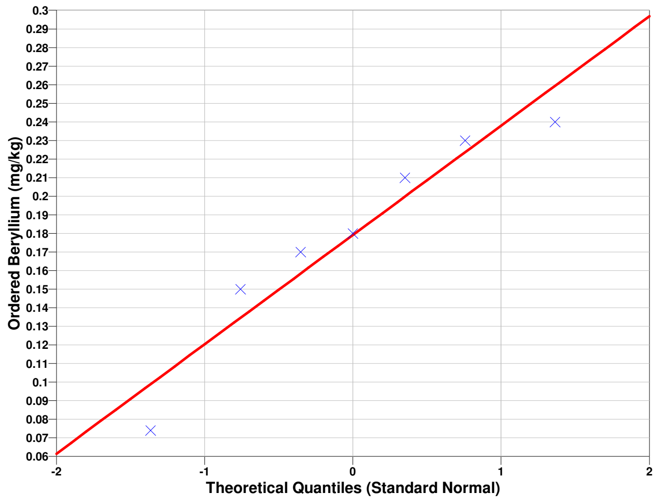
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Beryllium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9243
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.2207

95% Non-Parametric (Chebyshev) UCL	0.2724

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0.2207) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1747.1	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Chromium
The following data points were entered by the user for analysis.

Chromium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1.4	3.5	3.6	4.1	4.8	5	5.9			

SUMMARY STATISTICS for Chromium								
n	7							
Min	1.4							
Max	5.9							
Range	4.5							
Mean	4.0429							
Median	4.1							
Variance	2.0695							
StdDev	1.4386							
Std Error	0.54373							
Skewness	-0.86133							
Interquartile Range	1.5							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**

1.4	1.4	1.4	3.5	4.1	5	5.9	5.9	5.9

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Chromium	
Dixon Test Statistic	0.46667
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 1.4 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9348
Shapiro-Wilk 5% Critical Value	0.788

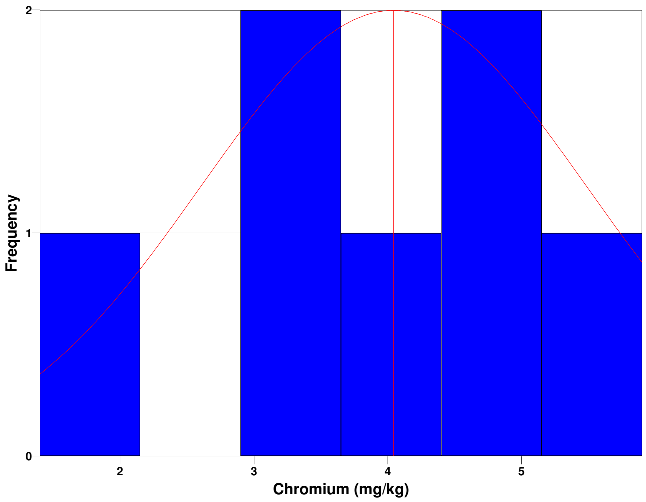
The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 1.4, do appear to follow a normal distribution at the 5% level of significance.

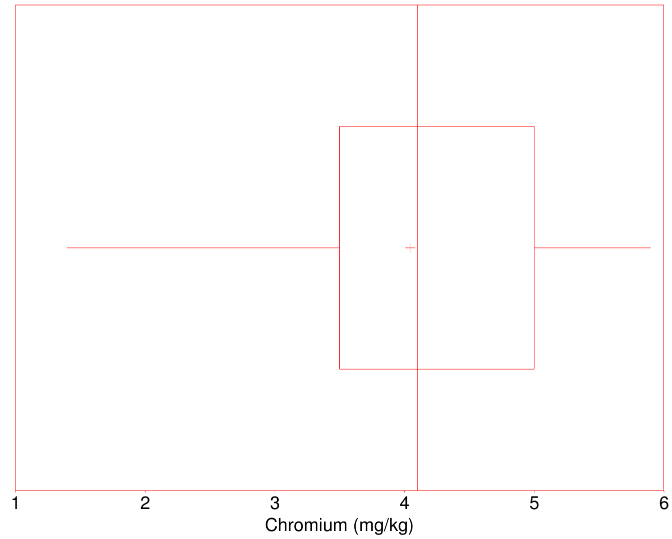
Data Plots for Chromium
Graphical displays of the data are shown below.

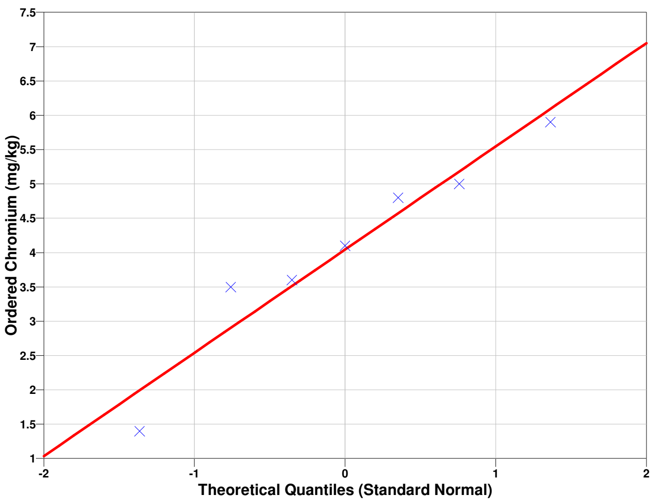
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Chromium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9462
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	5.099

95% Non-Parametric (Chebyshev) UCL	6.413

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (5.099) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-380.02	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Cobalt
The following data points were entered by the user for analysis.

Cobalt (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.36	0.92	0.93	1	1.1	1.2	1.35			

SUMMARY STATISTICS for Cobalt								
n	7							
Min	0.36							
Max	1.35							
Range	0.99							
Mean	0.98							
Median	1							
Variance	0.098433							
StdDev	0.31374							
Std Error	0.11858							
Skewness	-1.327							
Interquartile Range	0.28							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**

0.36	0.36	0.36	0.92	1	1.2	1.35	1.35	1.35

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Cobalt	
Dixon Test Statistic	0.56566
Dixon 5% Critical Value	0.507

The calculated test statistic exceeds the critical value, so the test rejects the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.36 is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Cobalt	
Min	0.36

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9171
Shapiro-Wilk 5% Critical Value	0.788

The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.36, do appear to follow a normal distribution at the 5% level of significance.

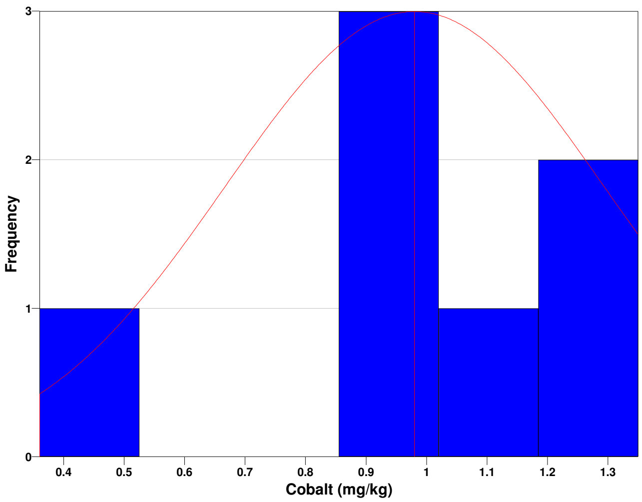
Data Plots for Cobalt
Graphical displays of the data are shown below.

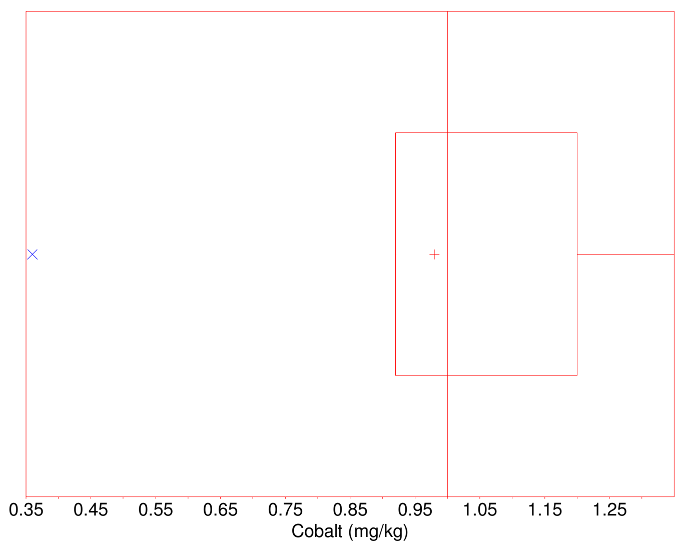
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

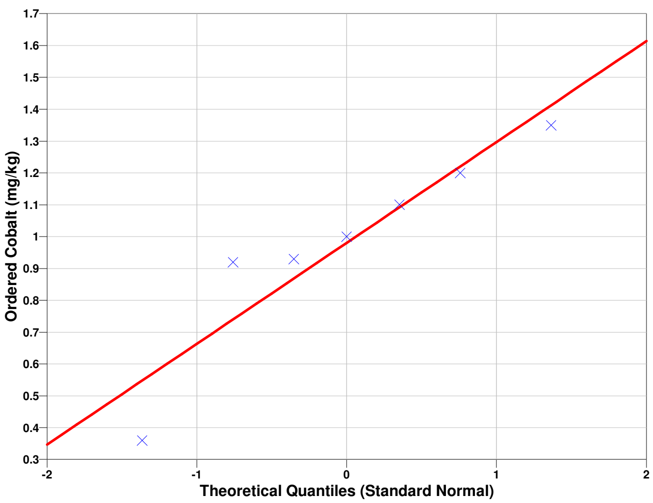
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate

substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Cobalt
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8918
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN

95% Parametric UCL	1.21
95% Non-Parametric (Chebyshev) UCL	1.497

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (1.21) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-7605.8	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Copper
The following data points were entered by the user for analysis.

Copper (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	2.5	2.6	3.2	3.9	3.9	4.2	4.6			

SUMMARY STATISTICS for Copper	
n	7
Min	2.5
Max	4.6
Range	2.1
Mean	3.5571
Median	3.9
Variance	0.64952
StdDev	0.80593
Std Error	0.30461
Skewness	-0.27787
Interquartile Range	1.6
Percentiles	

1%	5%	10%	25%	50%	75%	90%	95%	99%
2.5	2.5	2.5	2.6	3.9	4.2	4.6	4.6	4.6

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Copper	
Dixon Test Statistic	0.047619
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 2.5 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9466
Shapiro-Wilk 5% Critical Value	0.788

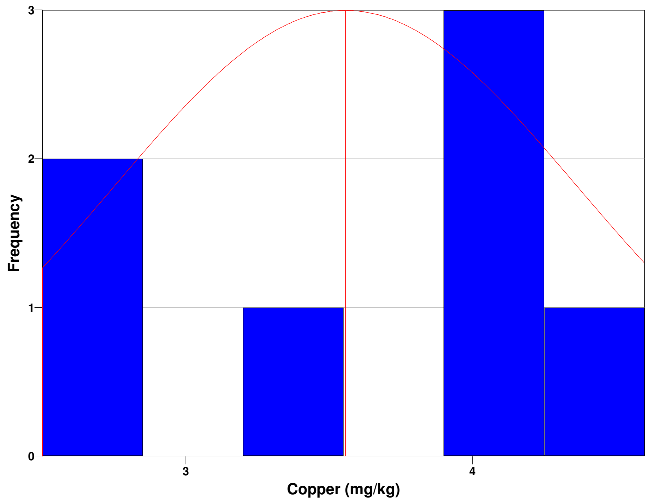
The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 2.5, do appear to follow a normal distribution at the 5% level of significance.

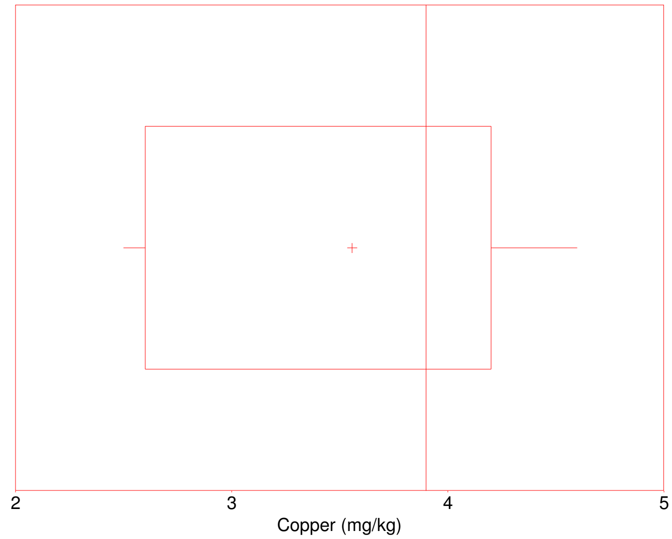
Data Plots for Copper
Graphical displays of the data are shown below.

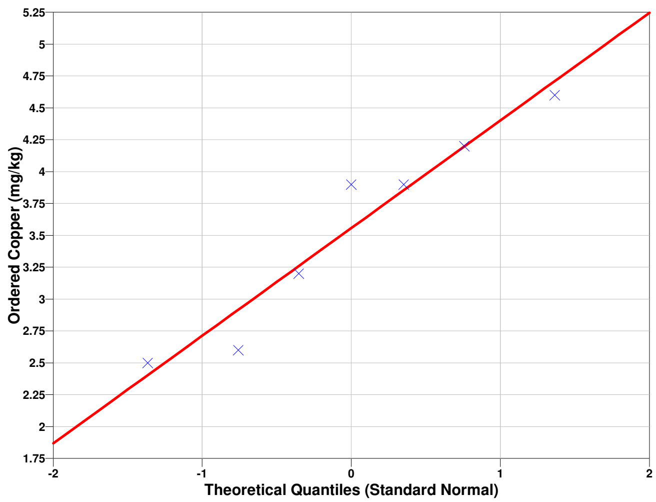
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Copper
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9185
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	4.149

95% Non-Parametric (Chebyshev) UCL	4.885

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (4.149) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1786	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Lead
The following data points were entered by the user for analysis.

Lead (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	3.3	4.5	4.7	5.8	7	7.9	13.5			

SUMMARY STATISTICS for Lead	
n	7
Min	3.3
Max	13.5
Range	10.2
Mean	6.6714
Median	5.8
Variance	11.496
StdDev	3.3905
Std Error	1.2815
Skewness	1.577
Interquartile Range	3.4

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**

3.3	3.3	3.3	4.5	5.8	7.9	13.5	13.5	13.5

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Lead	
Dixon Test Statistic	0.11765
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 3.3 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8277
Shapiro-Wilk 5% Critical Value	0.788

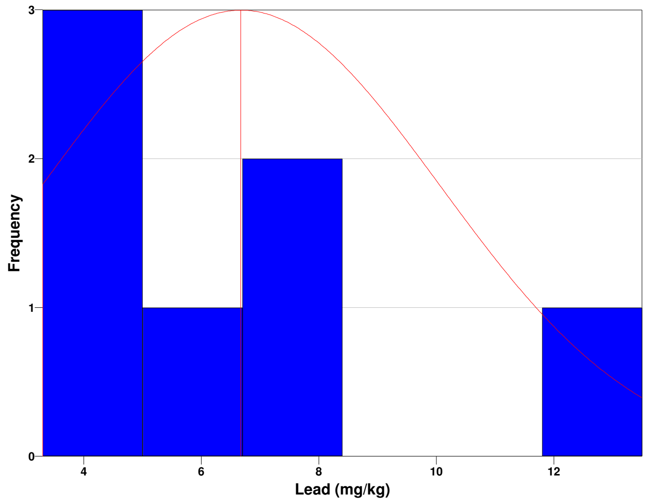
The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 3.3, do appear to follow a normal distribution at the 5% level of significance.

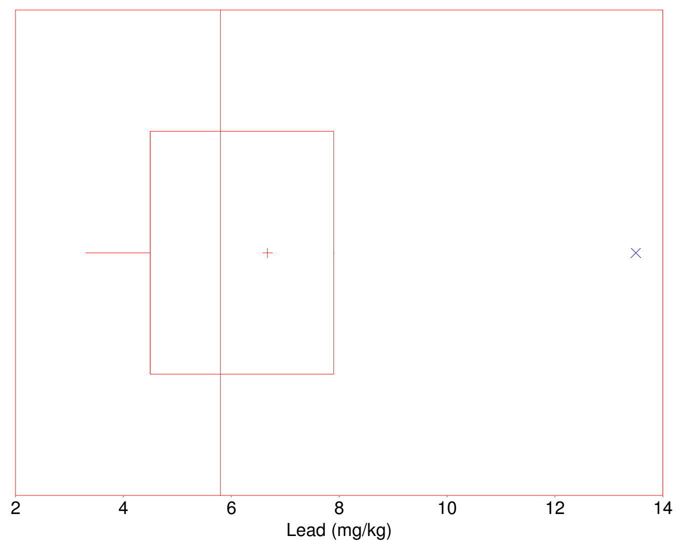
Data Plots for Lead
Graphical displays of the data are shown below.

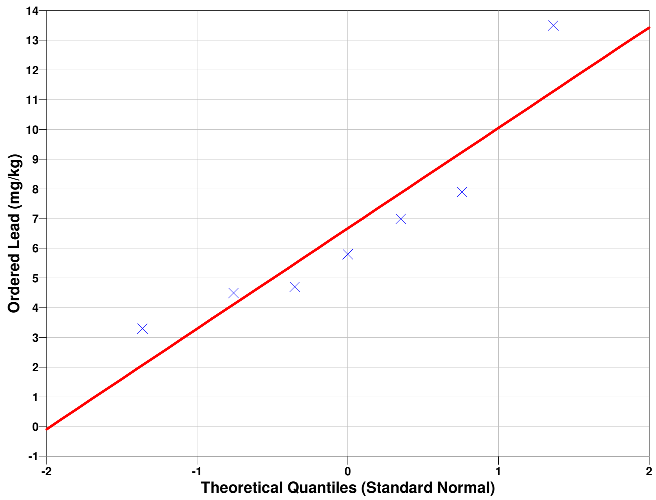
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Lead

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8619
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	9.162

95% Non-Parametric (Chebyshev) UCL	12.26

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (9.162) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-306.93	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Manganese
The following data points were entered by the user for analysis.

Manganese (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	53.3	78.7	84.5	95.9	100	113	226			

SUMMARY STATISTICS for Manganese								
n	7							
Min	53.3							
Max	226							
Range	172.7							
Mean	107.34							
Median	95.9							
Variance	3093.2							
StdDev	55.617							
Std Error	21.021							
Skewness	2.0015							
Interquartile Range	34.3							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**

53.3	53.3	53.3	78.7	95.9	113	226	226	226

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Manganese	
Dixon Test Statistic	0.14708
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 53.3 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7013
Shapiro-Wilk 5% Critical Value	0.788

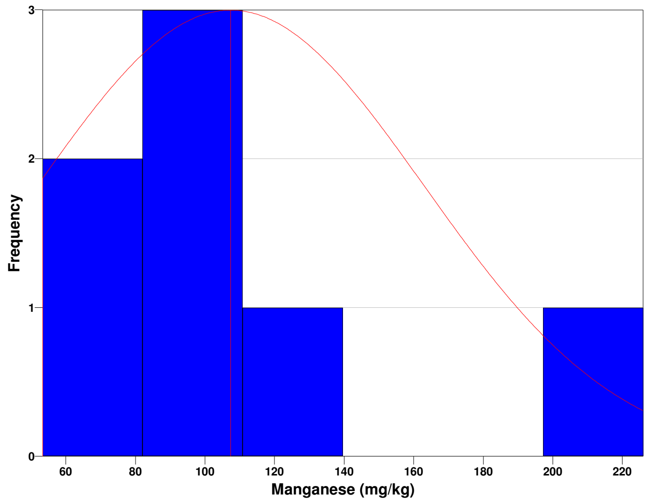
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 53.3, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

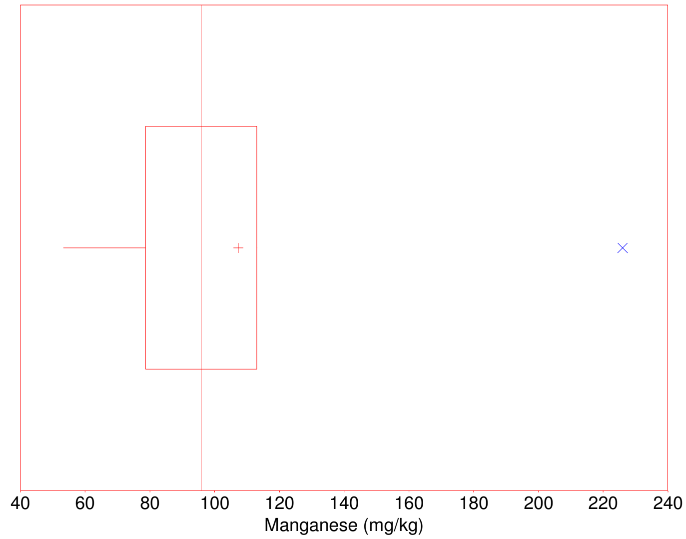
Data Plots for Manganese
Graphical displays of the data are shown below.

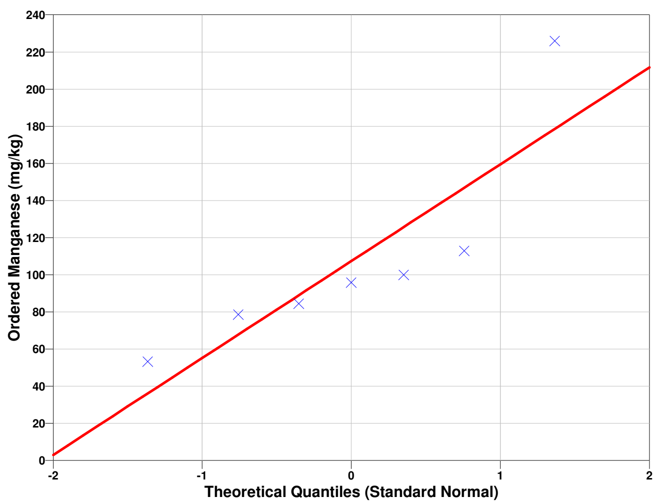
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Manganese

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7786
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	148.2

95% Non-Parametric (Chebyshev) UCL	199

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (199) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-148.99	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Data Analysis for Mercury
The following data points were entered by the user for analysis.

Mercury (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0049	0.008	0.008	0.0087	0.014	0.018	0.022			

SUMMARY STATISTICS for Mercury	
n	7
Min	0.0049
Max	0.022
Range	0.0171
Mean	0.011943
Median	0.0087
Variance	3.888e-005

StdDev				0.0062353				
Std Error				0.0023567				
Skewness				0.7143				
Interquartile Range				0.01				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0049	0.0049	0.0049	0.008	0.0087	0.018	0.022	0.022	0.022

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Mercury	
Dixon Test Statistic	0.18129
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.0049 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8587
Shapiro-Wilk 5% Critical Value	0.788

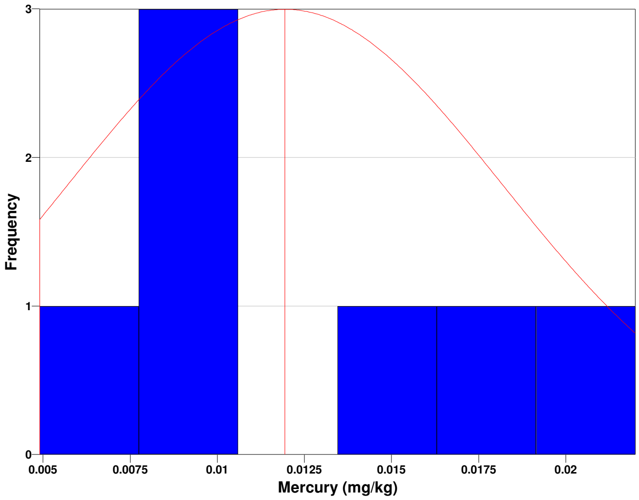
The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.0049, do appear to follow a normal distribution at the 5% level of significance.

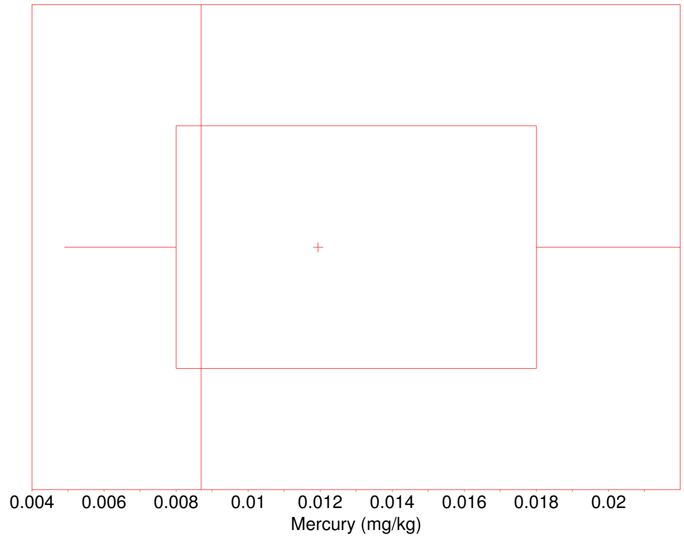
Data Plots for Mercury
Graphical displays of the data are shown below.

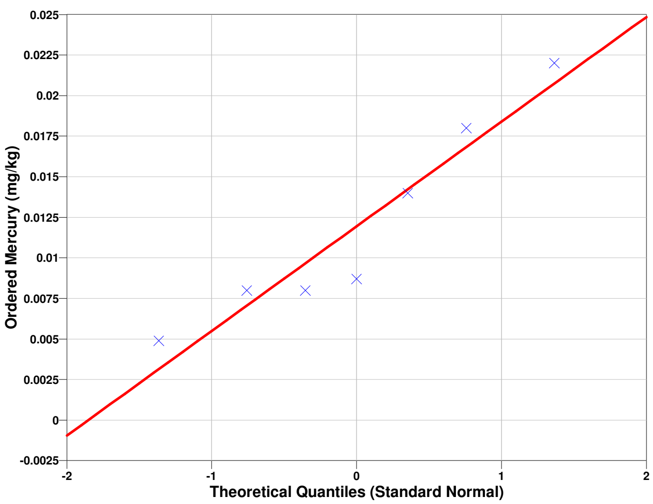
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Mercury

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.905
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that

assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.01652
95% Non-Parametric (Chebyshev) UCL	0.02222

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0.01652) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	Critical Value $t_{0.95}$	Null Hypothesis
-880.58	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Nickel
The following data points were entered by the user for analysis.

Nickel (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.59	1.7	1.8	2	2.1	2.15	2.5			

SUMMARY STATISTICS for Nickel	
n	7
Min	0.59
Max	2.5
Range	1.91
Mean	1.8343
Median	2
Variance	0.36806
StdDev	0.60668
Std Error	0.2293
Skewness	-1.6501

Interquartile Range				0.45				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.59	0.59	0.59	1.7	2	2.15	2.5	2.5	2.5

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Nickel	
Dixon Test Statistic	0.58115
Dixon 5% Critical Value	0.507

The calculated test statistic exceeds the critical value, so the test rejects the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.59 is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Nickel	
Min	0.59

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9605
Shapiro-Wilk 5% Critical Value	0.788

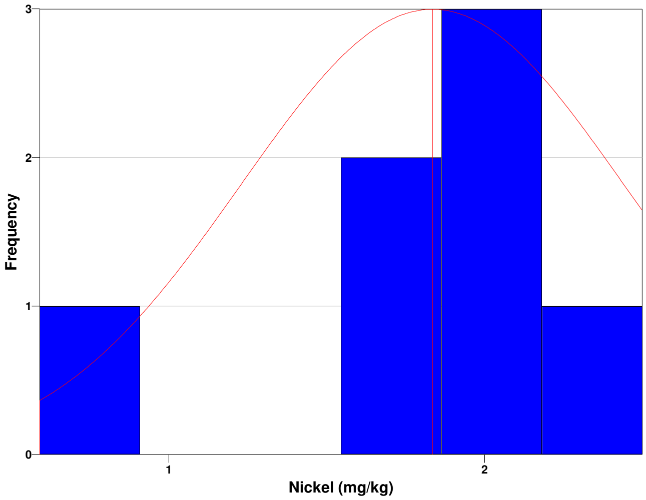
The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.59, do appear to follow a normal distribution at the 5% level of significance.

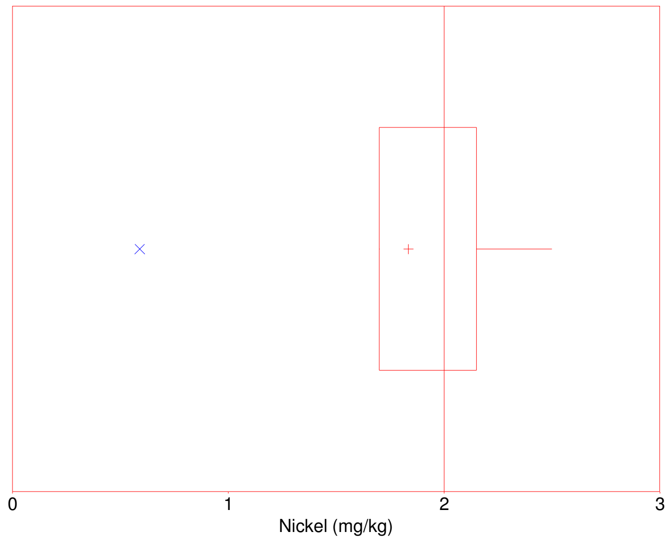
Data Plots for Nickel
Graphical displays of the data are shown below.

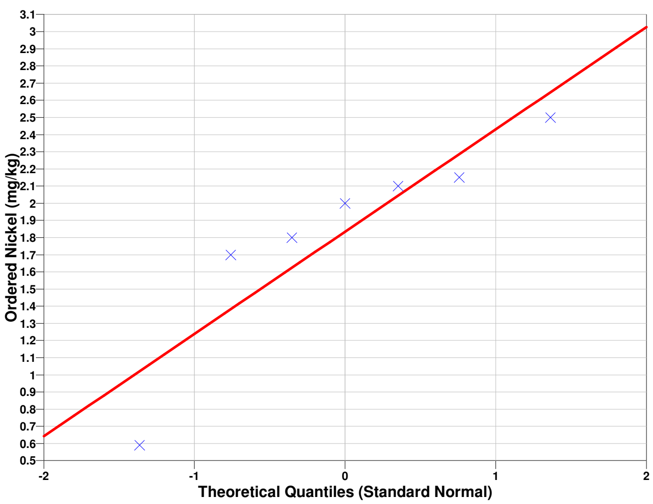
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Nickel
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8486
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that

assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	2.28
95% Non-Parametric (Chebyshev) UCL	2.834

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (2.28) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-3620.8	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Vanadium
The following data points were entered by the user for analysis.

Vanadium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	2.5	5.5	6.1	6.2	6.3	6.5	8.4			

SUMMARY STATISTICS for Vanadium	
n	7
Min	2.5
Max	8.4
Range	5.9
Mean	5.9286
Median	6.2
Variance	3.1024
StdDev	1.7614
Std Error	0.66573
Skewness	-1.0685

Interquartile Range				1				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
2.5	2.5	2.5	5.5	6.2	6.5	8.4	8.4	8.4

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Vanadium	
Dixon Test Statistic	0.50847
Dixon 5% Critical Value	0.507

The calculated test statistic exceeds the critical value, so the test rejects the null hypothesis that there are no outliers in the data, and concludes that the minimum value 2.5 is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Vanadium	
Min	2.5

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8049
Shapiro-Wilk 5% Critical Value	0.788

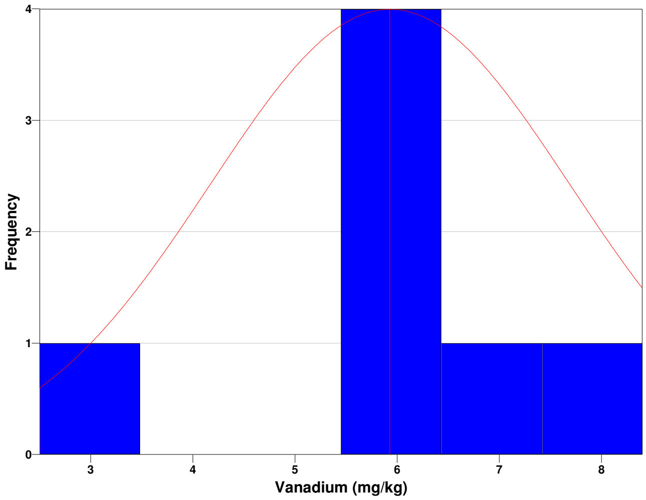
The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 2.5, do appear to follow a normal distribution at the 5% level of significance.

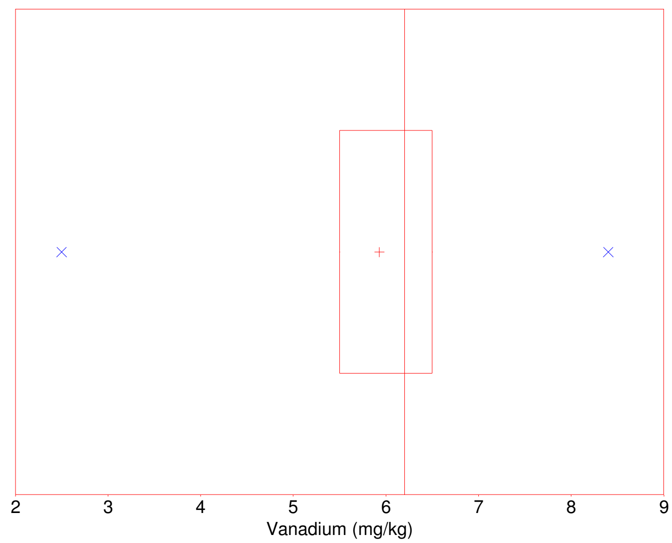
Data Plots for Vanadium
Graphical displays of the data are shown below.

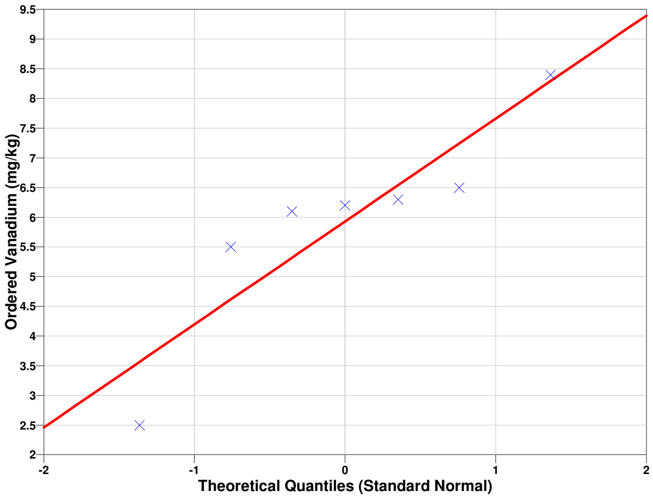
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Vanadium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8633
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that

assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	7.222
95% Non-Parametric (Chebyshev) UCL	8.83

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (7.222) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-428.23	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Zinc
The following data points were entered by the user for analysis.

Zinc (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	23.9	32.8	32.9	44	66.6	279	346			

SUMMARY STATISTICS for Zinc	
n	7
Min	23.9
Max	346
Range	322.1
Mean	117.89
Median	44
Variance	18230
StdDev	135.02
Std Error	51.032
Skewness	1.2754

Interquartile Range				246.2				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
23.9	23.9	23.9	32.8	44	279	346	346	346

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Zinc	
Dixon Test Statistic	0.027631
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 23.9 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7492
Shapiro-Wilk 5% Critical Value	0.788

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 23.9, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

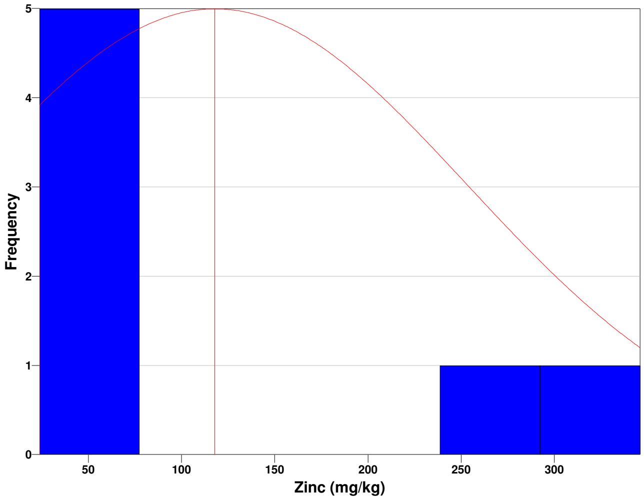
Data Plots for Zinc
Graphical displays of the data are shown below.

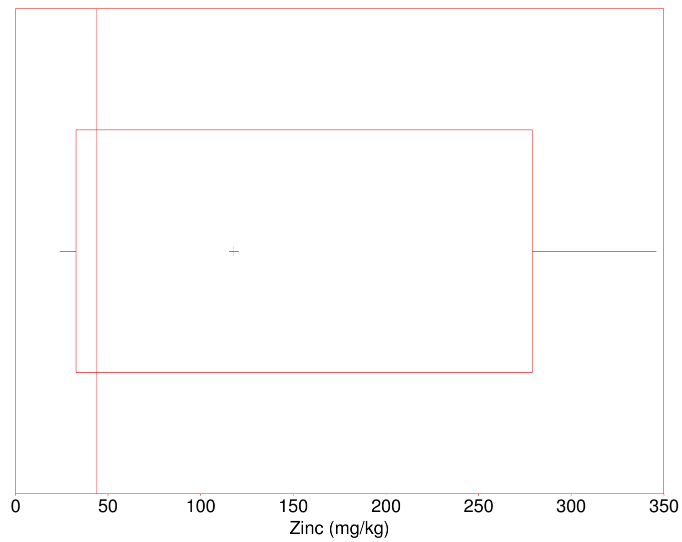
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

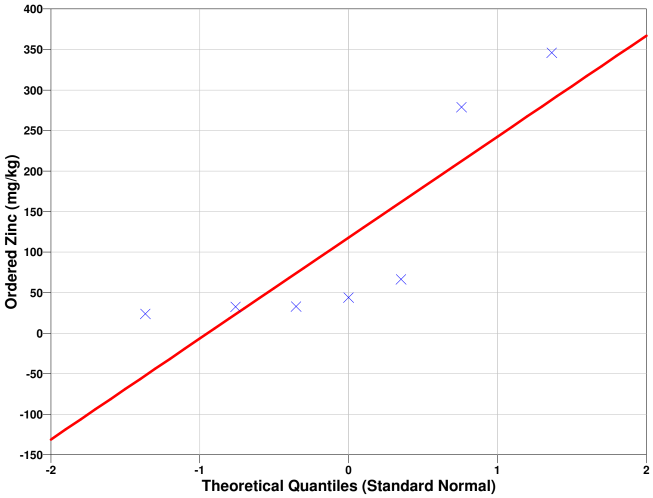
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the

Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Zinc

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7173
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	217
95% Non-Parametric (Chebyshev) UCL	340.3

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (340.3) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-192.11	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Data Analysis for Aluminum
The following data points were entered by the user for analysis.

Aluminum (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1760	3420	3590	4390	4420	4590	6020			

SUMMARY STATISTICS for Aluminum	
n	7
Min	1760
Max	6020
Range	4260
Mean	4027.1

Median				4390				
Variance				1.7123e+006				
StdDev				1308.6				
Std Error				494.59				
Skewness				-0.39144				
Interquartile Range				1170				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
1760	1760	1760	3420	4390	4590	6020	6020	6020

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Aluminum	
Dixon Test Statistic	0.38967
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 1760 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8938
Shapiro-Wilk 5% Critical Value	0.788

The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 1760, do appear to follow a normal distribution at the 5% level of significance.

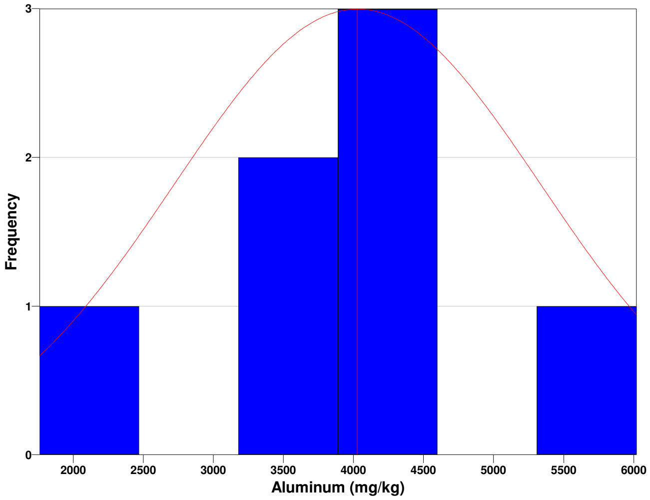
Data Plots for Aluminum
Graphical displays of the data are shown below.

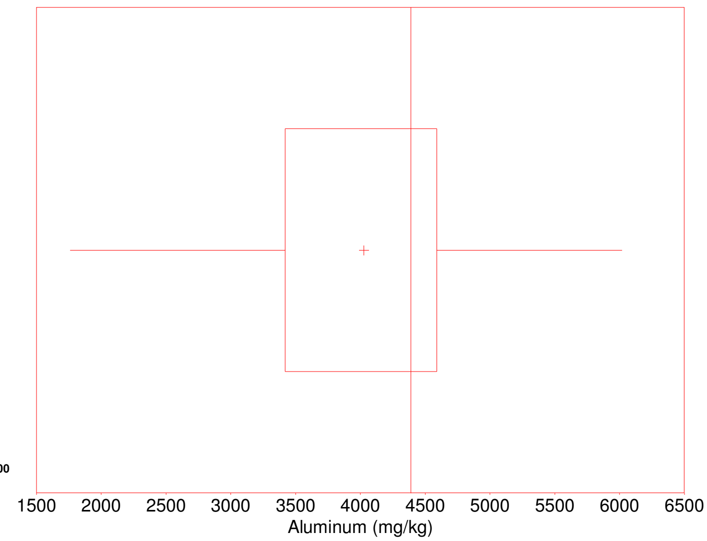
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

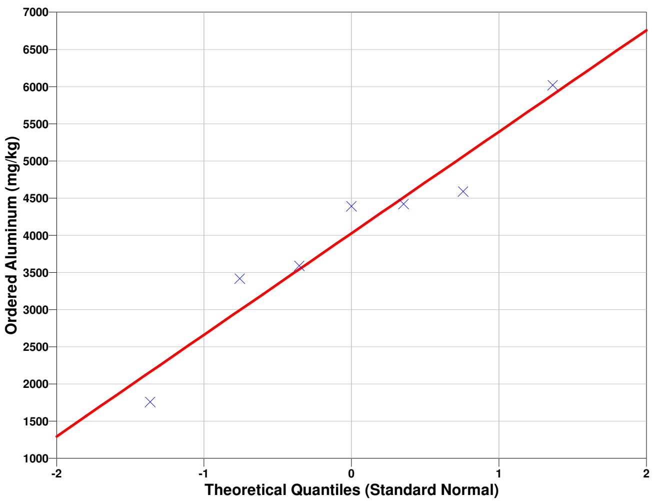
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted

individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Aluminum
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9512
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	4988
95% Non-Parametric (Chebyshev) UCL	6183

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (4988) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-5.0426	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Appendix C

VSP Reports of Calculated Minimum Sample Quantity
Report 12
Area of Concern – 3
Minimum Sample Quantity Calculation for Surface Soil using Human Health Benchmarks and Delta Method 2

Random sampling locations for comparing a mean with a fixed threshold (parametric)

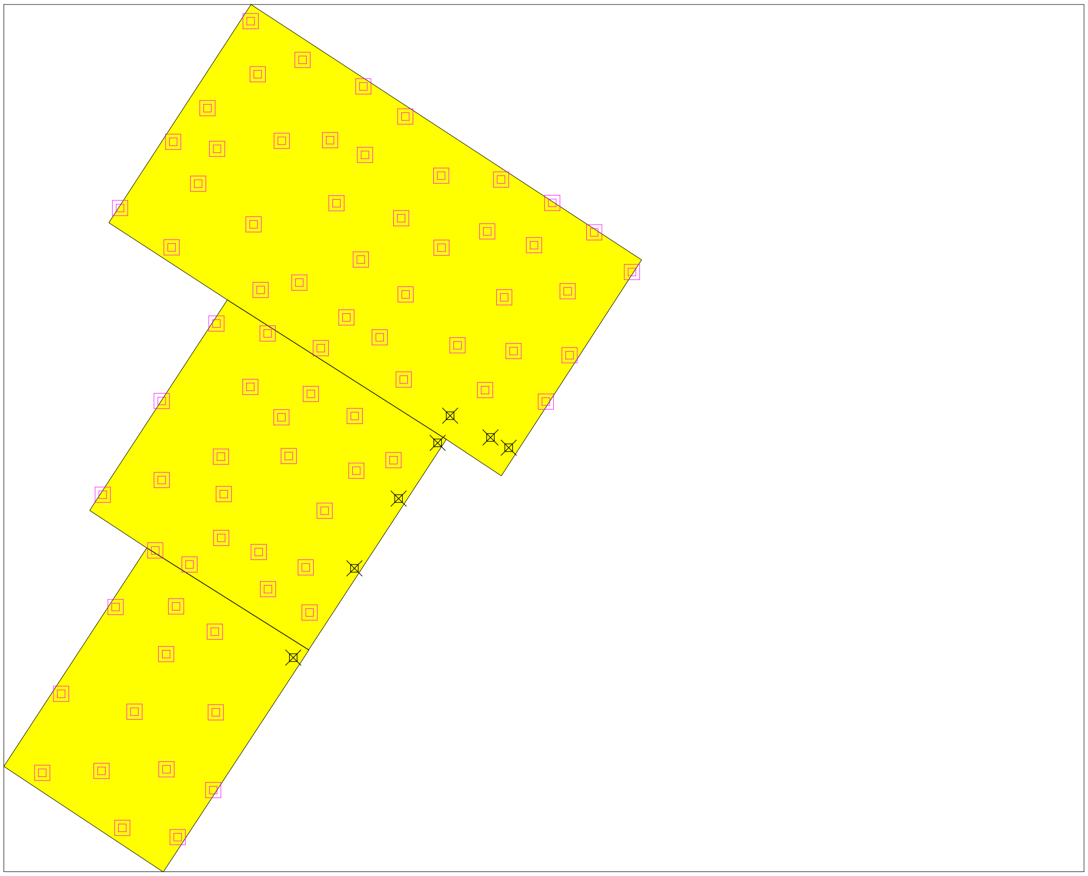
Summary

This report summarizes the sampling design, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design for Arsenic, the driving analyte (the analyte which required the largest number of samples). A figure that shows sampling locations in the field and a table that lists sampling location coordinates are also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean to a fixed threshold
Type of Sampling Design	Parametric
Sample Placement (Location) in the Field	Simple random sampling
Working (Null) Hypothesis	The mean value at the site exceeds the threshold
Formula for calculating number of sampling locations	Student's t-test
Calculated total number of samples	82
Number of samples on map [a]	82
Number of selected sample areas [b]	1
Specified sampling area [c]	602117.04 m^2
Total cost of sampling [d]	$42,000.00

[a] This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[d] Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.



Area: Area 1					
X Coord	**Y Coord**	**Label**	**Value**	**Type**	**Historical**
680077.3540	3083115.5330	J-50S		Manual	T
680141.8730	3083080.8800	J-52S		Manual	T
680170.5600	3083064.6740	J-53S		Manual	T
679924.8150	3082872.3490	J-47S		Manual	T
679994.9690	3082983.5100	J-48S		Manual	T
680057.6580	3083072.0750	J-49S		Manual	T
679827.1150	3082729.7460	J-51S		Manual	T
679426.9178	3082546.1029		0	Adaptive-Fill	
680062.9378	3083498.6378		0	Adaptive-Fill	
679759.2113	3083745.0098		0	Adaptive-Fill	
679617.2108	3083139.1688		0	Adaptive-Fill	
680367.4551	3083344.7483		0	Adaptive-Fill	
679763.9175	3083420.9435		0	Adaptive-Fill	
679543.7886	3082810.2058		0	Adaptive-Fill	
679699.6690	3082518.4928		0	Adaptive-Fill	
679871.0853	3083223.4678		0	Adaptive-Fill	
679712.5768	3082920.5418		0	Adaptive-Fill	
679551.2602	3083447.1072		0	Adaptive-Fill	

679939.1858	3083641.1126		0	Adaptive-Fill	
680163.8120	3083304.6334		0	Adaptive-Fill	
679523.2811	3082989.7734		0	Adaptive-Fill	
680239.9496	3083455.1292		0	Adaptive-Fill	
679573.9796	3082643.6988		0	Adaptive-Fill	
679820.1221	3083051.1266		0	Adaptive-Fill	
679554.9085	3082458.1355		0	Adaptive-Fill	
680006.4667	3083309.1139		0	Adaptive-Fill	
679690.6389	3083606.4039		0	Adaptive-Fill	
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679896.2707	3083454.4282		0	Adaptive-Fill	
679702.1612	3082771.3104		0	Adaptive-Fill	
680267.5955	3083211.9280		0	Adaptive-Fill	
679703.5475	3082642.7428		0	Adaptive-Fill	
679808.6457	3083553.9124		0	Adaptive-Fill	
679925.3043	3083115.2348		0	Adaptive-Fill	
679758.6411	3083161.4740		0	Adaptive-Fill	
680136.4022	3083409.7935		0	Adaptive-Fill	
679836.9580	3083327.9751		0	Adaptive-Fill	
679712.0378	3083050.2967		0	Adaptive-Fill	
680089.0696	3083227.8993		0	Adaptive-Fill	
679877.0047	3082964.2125		0	Adaptive-Fill	
679633.3191	3083384.2219		0	Adaptive-Fill	
679786.9492	3082839.1642		0	Adaptive-Fill	
679457.0005	3082672.3666		0	Adaptive-Fill	
679607.0939	3082900.5841		0	Adaptive-Fill	
679842.0571	3083683.3785		0	Adaptive-Fill	
679675.4437	3083485.7769		0	Adaptive-Fill	
680264.3925	3083314.1911		0	Adaptive-Fill	
679999.0284	3083430.5000		0	Adaptive-Fill	
679521.3857	3082548.8818		0	Adaptive-Fill	
680003.4954	3083173.5629		0	Adaptive-Fill	
679941.3596	3083531.7221		0	Adaptive-Fill	
679624.3947	3082735.6467		0	Adaptive-Fill	
680178.4535	3083219.0057		0	Adaptive-Fill	
679786.4829	3083246.7394		0	Adaptive-Fill	
679617.6289	3083013.3054		0	Adaptive-Fill	
680229.9504	3083138.3405		0	Adaptive-Fill	
680005.9345	3083592.9846		0	Adaptive-Fill	
679934.8164	3083364.9597		0	Adaptive-Fill	
679927.7212	3083027.8861		0	Adaptive-Fill	

679643.1423	3082443.2987		0	Adaptive-Fill	
680063.7195	3083383.3872		0	Adaptive-Fill	
679770.7664	3083660.4607		0	Adaptive-Fill	
679624.9918	3082551.8071		0	Adaptive-Fill	
680211.1403	3083387.9243		0	Adaptive-Fill	
679853.3353	3082801.7035		0	Adaptive-Fill	
680307.0614	3083408.0083		0	Adaptive-Fill	
679636.0498	3083552.5289		0	Adaptive-Fill	
679855.5292	3083150.5670		0	Adaptive-Fill	
679640.1931	3082811.3992		0	Adaptive-Fill	
680158.5552	3083492.1984		0	Adaptive-Fill	
679775.1692	3083316.2930		0	Adaptive-Fill	
679705.7655	3083541.5976		0	Adaptive-Fill	
679986.7870	3083044.5454		0	Adaptive-Fill	
679964.8882	3083240.6268		0	Adaptive-Fill	
679661.6192	3082878.5564		0	Adaptive-Fill	
679885.9266	3083555.1743		0	Adaptive-Fill	
679912.0578	3083272.3824		0	Adaptive-Fill	
680132.7601	3083156.3609		0	Adaptive-Fill	
679716.5135	3082990.5446		0	Adaptive-Fill	
679808.5054	3083113.3252		0	Adaptive-Fill	
679772.1250	3082898.3083		0	Adaptive-Fill	
679846.9841	3082873.6739		0	Adaptive-Fill	

Primary Sampling Objective
The primary purpose of sampling at this site is to compare a mean value of a site with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the mean value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the mean value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative hypothesis, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach
A parametric random sampling approach was used to determine the number of samples and to specify sampling locations. A parametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that parametric assumptions are reasonable. These assumptions will be examined in post-sampling data analysis.

Both parametric and non-parametric approaches rely on assumptions about the population. However, non-parametric approaches typically require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than the number of samples required by non-parametric approaches.

Locating the sample points randomly provides data that are separated by many distances, whereas systematic samples are all equidistant apart. Therefore, random sampling provides more information about the spatial structure of the potential contamination than systematic sampling does. As with systematic sampling, random sampling also provides information regarding the mean value, but there is the possibility that areas of the site will not be represented with the same frequency as if uniform grid sampling were performed.

Number of Total Samples: Calculation Equation and Inputs
The equation used to calculate the number of samples is based on a Student's t-test. For this site, the null hypothesis is

rejected in favor of the alternative hypothesis if the sample mean is sufficiently smaller than the threshold. The number of samples to collect is calculated so that 1) there will be a high probability ($1-\beta$) of rejecting the null hypothesis if the alternative hypothesis is true and 2) a low probability (α) of rejecting the null hypothesis if the null hypothesis is true.

The formula used to calculate the number of samples is:

$$n = \frac{S^2}{\Delta^2}\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2 + 0.5Z_{1-\alpha}^2$$

where
n is the number of samples,
S is the estimated standard deviation of the measured values including analytical error,
Δ is the width of the gray region,
α is the acceptable probability of incorrectly concluding the site mean is less than the threshold,
β is the acceptable probability of incorrectly concluding the site mean exceeds the threshold,
$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is $1-\alpha$,
$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is $1-\beta$.

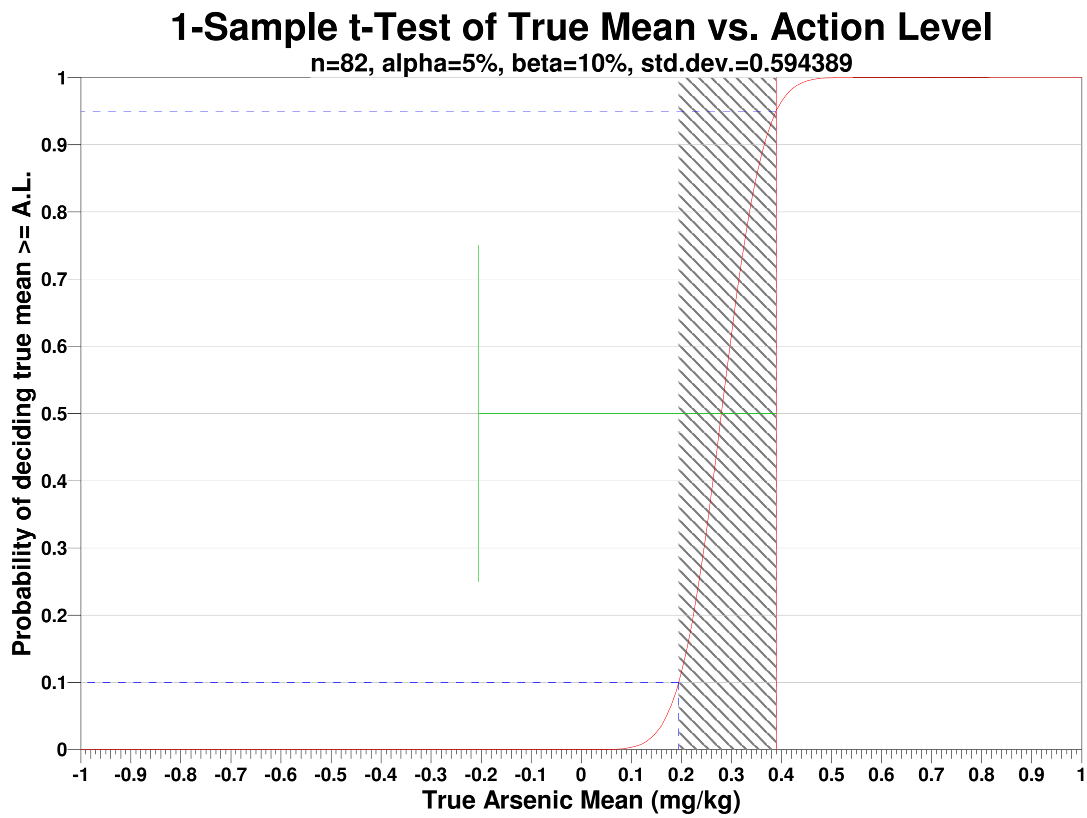
The values of these inputs that result in the calculated number of sampling locations are:

Analyte	**n**	**Parameter**					
		S	**Δ**	**α**	**β**	**$Z_{1-\alpha}$** [a]	**$Z_{1-\beta}$** [b]
New Location	2	0.1 mg/kg	10 mg/kg	0.05	0.1	1.64485	1.28155
Arsenic	82	0.594389 mg/kg	0.194812 mg/kg	0.05	0.1	1.64485	1.28155
Barium	2	209.832 mg/kg	3920.25 mg/kg	0.05	0.1	1.64485	1.28155
Beryllium	2	0.056614 mg/kg	18.7822 mg/kg	0.05	0.1	1.64485	1.28155
Chromium	2	1.43858 mg/kg	105.338 mg/kg	0.05	0.1	1.64485	1.28155
Cobalt	2	0.313741 mg/kg	451.447 mg/kg	0.05	0.1	1.64485	1.28155
Copper	2	0.80593 mg/kg	273.798 mg/kg	0.05	0.1	1.64485	1.28155
Lead	2	3.39053 mg/kg	200 mg/kg	0.05	0.1	1.64485	1.28155
Manganese	2	55.6166 mg/kg	1619.65 mg/kg	0.05	0.1	1.64485	1.28155
Mercury	2	0.00623534 mg/kg	1.04361 mg/kg	0.05	0.1	1.64485	1.28155
Nickel	2	0.606681 mg/kg	416.052 mg/kg	0.05	0.1	1.64485	1.28155
Vanadium	2	1.76136 mg/kg	145.507 mg/kg	0.05	0.1	1.64485	1.28155
Zinc	2	135.018 mg/kg	4960.74 mg/kg	0.05	0.1	1.64485	1.28155
Aluminum	3	1307.29 mg/kg	3260.58 mg/kg	0.05	0.1	1.64485	1.28155

[a] This value is automatically calculated by VSP based upon the user defined value of α.
[b] This value is automatically calculated by VSP based upon the user defined value of β.

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000) for Arsenic, the driving analyte. It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true mean values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at $1-\alpha$ on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at $1-\alpha$. If any of the inputs change, the number of samples that result in the correct curve changes.



Statistical Assumptions
The assumptions associated with the formulas for computing the number of samples are:

1. the sample mean is normally distributed (this happens if the data are roughly symmetric or the sample size is more than 30; for extremely skewed data sets, additional samples may be required for the sample mean to be normally distributed),
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected randomly.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the sample locations were selected using a random process.

Sensitivity Analysis
The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that μ > action level and alpha (%), probability of mistakenly concluding that μ < action level. The following table shows the results of this analysis.

Number of Samples							
AL=9921.47		α=5		α=10		α=15	
		s=270.036	s=135.018	s=270.036	s=135.018	s=270.036	s=135.018
LBGR=90	β=5	519836102	129959027	411358855	102839715	345333367	86333343
	β=10	411358855	102839715	315561561	78890391	258091177	64522795
	β=15	345333368	86333343	258091178	64522795	206392882	51598221
LBGR=80	β=5	129959027	32489758	102839715	25709930	86333343	21583336
	β=10	102839715	25709930	78890391	19722599	64522795	16130700
	β=15	86333343	21583337	64522795	16130700	51598221	12899556
LBGR=70	β=5	57759569	14439894	45706541	11426636	38370375	9592595

	β=10	45706541	11426637	35062397	8765600	28676798	7169200
	β=15	38370376	9592595	28676799	7169201	22932543	5733137

s = Standard Deviation
LBGR = Lower Bound of Gray Region (% of Action Level)
β = Beta (%), Probability of mistakenly concluding that μ > action level
α = Alpha (%), Probability of mistakenly concluding that μ < action level
AL = Action Level (Threshold)

Cost of Sampling
The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that are based on the number of samples collected and measured. Based on the numbers of samples determined above, the estimated total cost of sampling and analysis at this site is $42,000.00, which averages out to a per sample cost of $512.20. The following table summarizes the inputs and resulting cost estimates.

COST INFORMATION			
Cost Details	**Per Analysis**	**Per Sample**	**82 Samples**
Field collection costs		$100.00	$8,200.00
Analytical costs	$400.00	$400.00	$32,800.00
Sum of Field & Analytical costs		**$500.00**	**$41,000.00**
Fixed planning and validation costs			$1,000.00
Total cost			**$42,000.00**

Data Analysis for New Location
The following data points were entered by the user for analysis.

New Location (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0					

SUMMARY STATISTICS for New Location	
n	75
Min	0
Max	0
Range	0
Mean	0
Median	0
Variance	0

StdDev				0				
Std Error				0				
Skewness				-1.#IND				
Interquartile Range				0				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0	0	0	0	0	0	0	0	0

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for New Location			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	0	-1	Yes

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Lilliefors test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Lilliefors Test Statistic	1.061e+292
Lilliefors 5% Critical Value	1.376e-313

The calculated Lilliefors test statistic exceeds the 5% Lilliefors critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

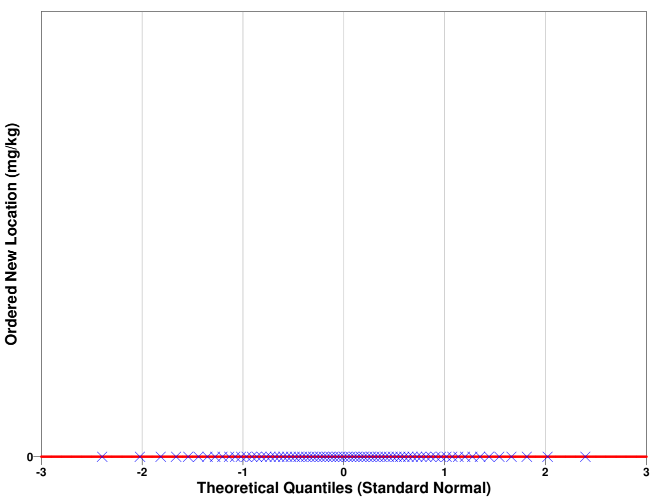
Data Plots for New Location
Graphical displays of the data are shown below.

The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends

to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.



For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for New Location

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Lilliefors test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Lilliefors Test Statistic	0
Lilliefors 5% Critical Value	0.1023

The calculated Lilliefors test statistic is less than the 5% Lilliefors critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0
95% Non-Parametric (Chebyshev) UCL	0

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=75 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=74 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.#IND	1.6657	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Data Analysis for Arsenic
The following data points were entered by the user for analysis.

Arsenic (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.72	0.96	0.965	1	1	1.1	2.5			

SUMMARY STATISTICS for Arsenic	
n	7
Min	0.72
Max	2.5
Range	1.78
Mean	1.1779

Median				1				
Variance				0.3533				
StdDev				0.59439				
Std Error				0.22466				
Skewness				2.4261				
Interquartile Range				0.14				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.72	0.72	0.72	0.96	1	1.1	2.5	2.5	2.5

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Arsenic	
Dixon Test Statistic	0.13483
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.72 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5638
Shapiro-Wilk 5% Critical Value	0.788

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.72, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

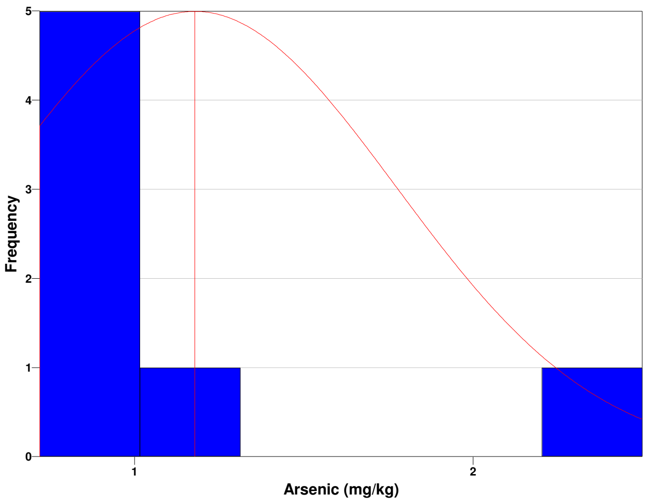
Data Plots for Arsenic
Graphical displays of the data are shown below.

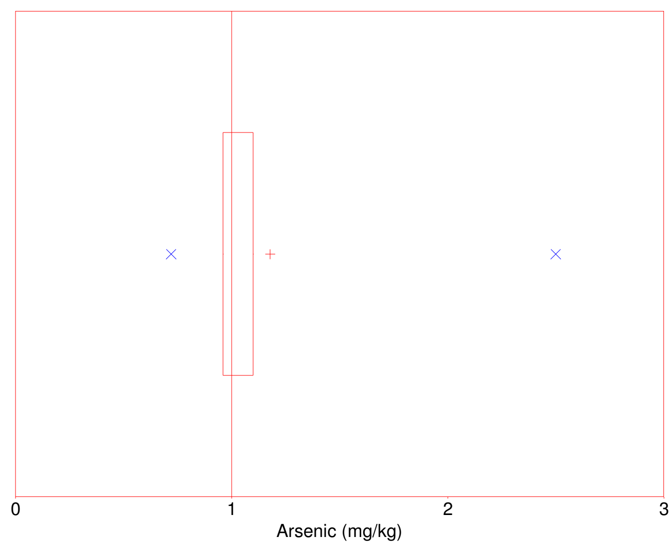
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

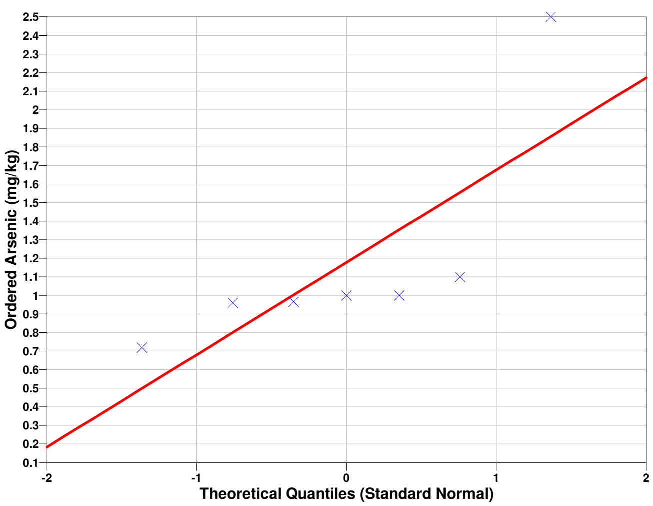
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends

to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Arsenic
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6313
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	1.614
95% Non-Parametric (Chebyshev) UCL	2.157

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (2.157) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
3.5086	1.9432	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
0	6	Cannot Reject
Note: There may not be enough data to reject the null hypothesis (and conclude site is clean) with 95% confidence using the MARSSIM sign test.		

Data Analysis for Barium
The following data points were entered by the user for analysis.

Barium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

0	16.6	37.9	74.4	139	206	224	630			

SUMMARY STATISTICS for Barium								
n	7							
Min	16.6							
Max	630							
Range	613.4							
Mean	189.7							
Median	139							
Variance	44030							
StdDev	209.83							
Std Error	79.309							
Skewness	1.8956							
Interquartile Range	186.1							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
16.6	16.6	16.6	37.9	139	224	630	630	630

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Barium	
Dixon Test Statistic	0.034724
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 16.6 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8015
Shapiro-Wilk 5% Critical Value	0.788

The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 16.6, do appear to follow a normal distribution at the 5% level of significance.

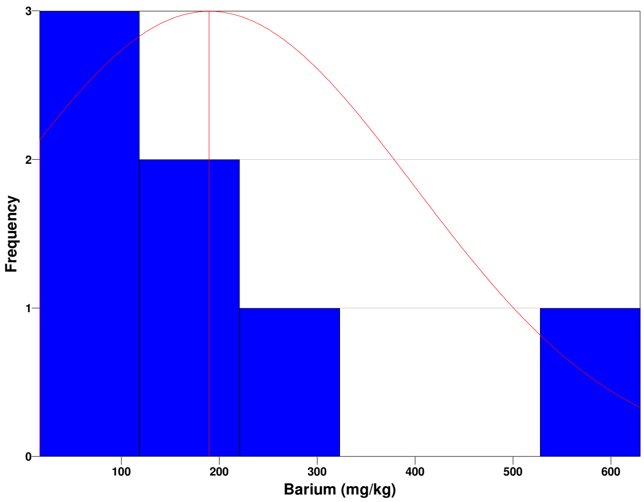
Data Plots for Barium
Graphical displays of the data are shown below.

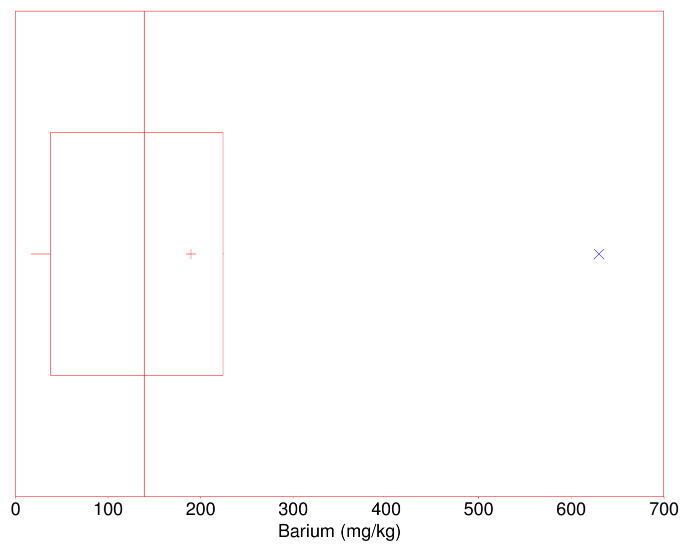
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

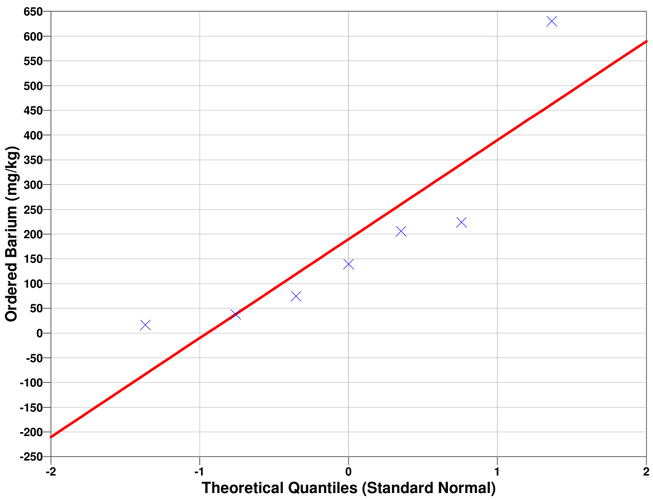
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Barium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7912
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	343.8
95% Non-Parametric (Chebyshev) UCL	535.4

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (535.4) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-96.468	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Data Analysis for Beryllium
The following data points were entered by the user for analysis.

Beryllium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.074	0.15	0.17	0.18	0.21	0.23	0.24			

SUMMARY STATISTICS for Beryllium								
n	7							
Min	0.074							
Max	0.24							
Range	0.166							
Mean	0.17914							
Median	0.18							
Variance	0.0032051							
StdDev	0.056614							
Std Error	0.021398							
Skewness	-1.0307							
Interquartile Range	0.08							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.074	0.074	0.074	0.15	0.18	0.23	0.24	0.24	0.24

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Beryllium	
Dixon Test Statistic	0.45783
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.074 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9444
Shapiro-Wilk 5% Critical Value	0.788

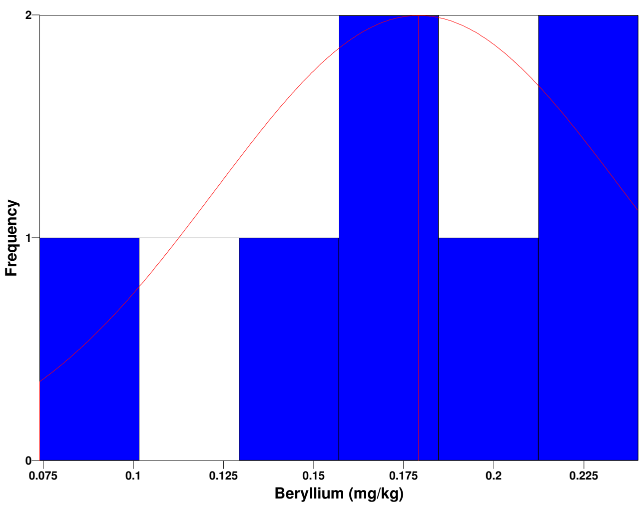
The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.074, do appear to follow a normal distribution at the 5% level of significance.

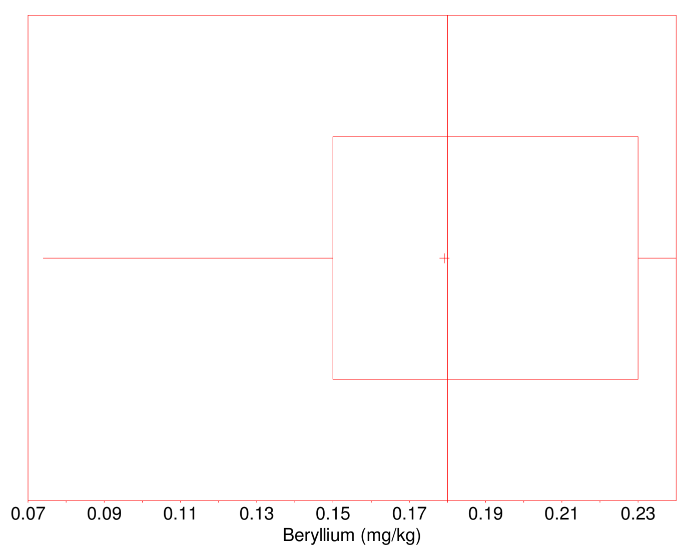
Data Plots for Beryllium
Graphical displays of the data are shown below.

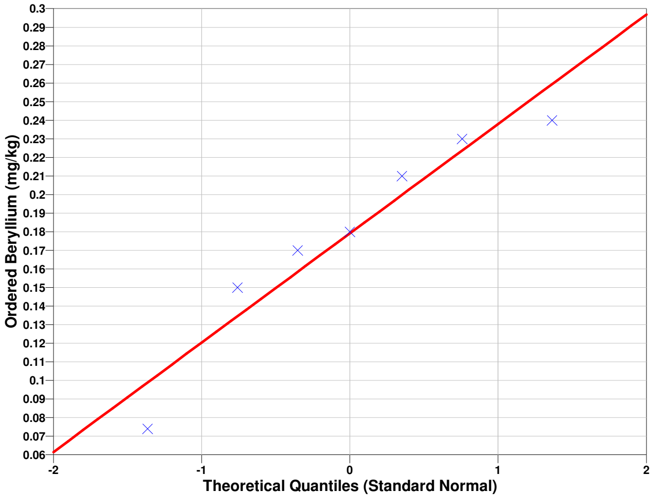
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Beryllium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9243
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.2207
95% Non-Parametric (Chebyshev) UCL	0.2724

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0.2207) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test

A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where

x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1747.1	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Chromium
The following data points were entered by the user for analysis.

Chromium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1.4	3.5	3.6	4.1	4.8	5	5.9			

SUMMARY STATISTICS for Chromium								
n	7							
Min	1.4							
Max	5.9							
Range	4.5							
Mean	4.0429							
Median	4.1							
Variance	2.0695							
StdDev	1.4386							
Std Error	0.54373							
Skewness	-0.86133							
Interquartile Range	1.5							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
1.4	1.4	1.4	3.5	4.1	5	5.9	5.9	5.9

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Chromium	
Dixon Test Statistic	0.46667
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 1.4 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9348
Shapiro-Wilk 5% Critical Value	0.788

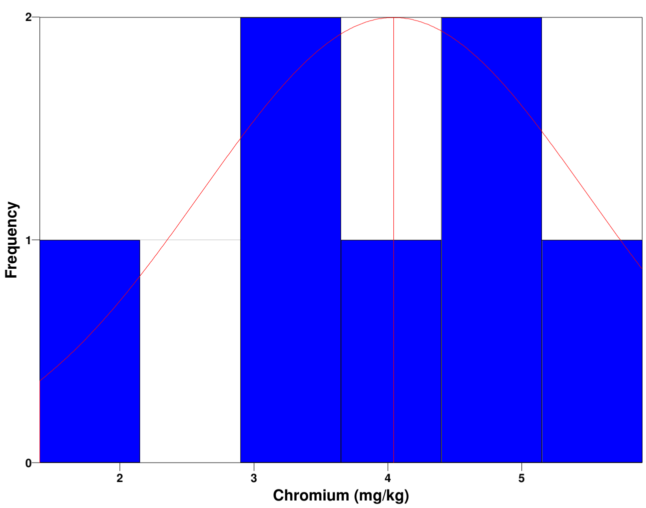
The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 1.4, do appear to follow a normal distribution at the 5% level of significance.

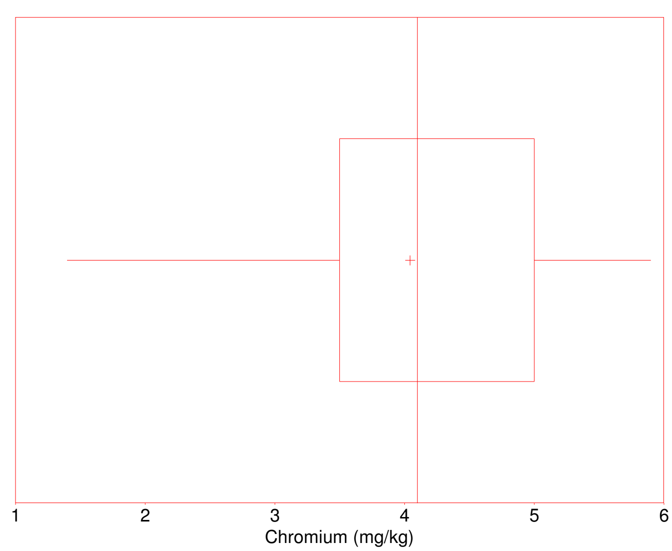
Data Plots for Chromium
Graphical displays of the data are shown below.

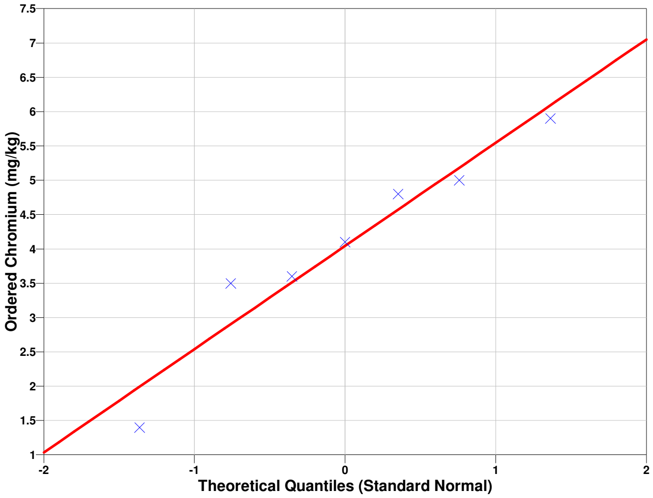
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Chromium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9462
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	5.099
95% Non-Parametric (Chebyshev) UCL	6.413

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (5.099) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-380.02	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Cobalt
The following data points were entered by the user for analysis.

Cobalt (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.36	0.92	0.93	1	1.1	1.2	1.35			

SUMMARY STATISTICS for Cobalt	
n	7
Min	0.36
Max	1.35
Range	0.99
Mean	0.98
Median	1
Variance	0.098433
StdDev	0.31374
Std Error	0.11858
Skewness	-1.327
Interquartile Range	0.28

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.36	0.36	0.36	0.92	1	1.2	1.35	1.35	1.35

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Cobalt	
Dixon Test Statistic	0.56566
Dixon 5% Critical Value	0.507

The calculated test statistic exceeds the critical value, so the test rejects the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.36 is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Cobalt	
Min	0.36

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9171
Shapiro-Wilk 5% Critical Value	0.788

The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.36, do appear to follow a normal distribution at the 5% level of significance.

Data Plots for Cobalt
Graphical displays of the data are shown below.

The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

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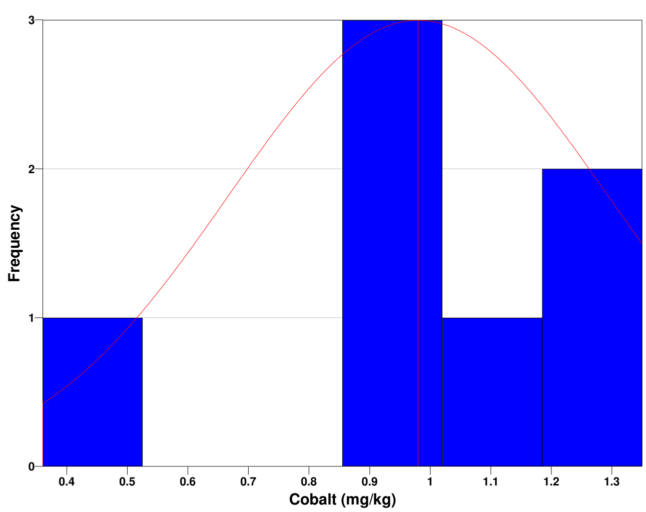
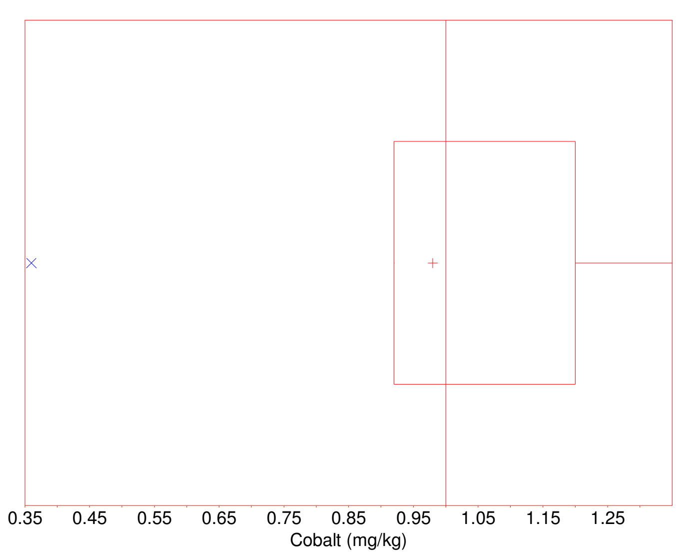
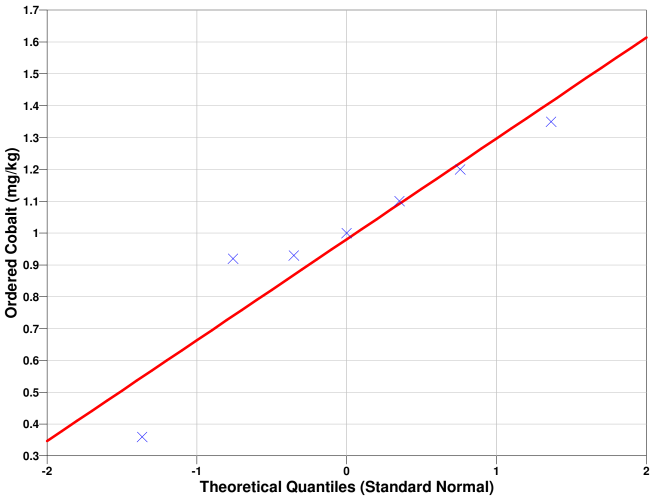






For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Cobalt
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8918
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	1.21
95% Non-Parametric (Chebyshev) UCL	1.497

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (1.21) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-7605.8	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Copper
The following data points were entered by the user for analysis.

Copper (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	2.5	2.6	3.2	3.9	3.9	4.2	4.6			

SUMMARY STATISTICS for Copper	
n	7
Min	2.5
Max	4.6
Range	2.1
Mean	3.5571
Median	3.9
Variance	0.64952
StdDev	0.80593
Std Error	0.30461
Skewness	-0.27787
Interquartile Range	1.6

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
2.5	2.5	2.5	2.6	3.9	4.2	4.6	4.6	4.6

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Copper	
Dixon Test Statistic	0.047619
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 2.5 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9466
Shapiro-Wilk 5% Critical Value	0.788

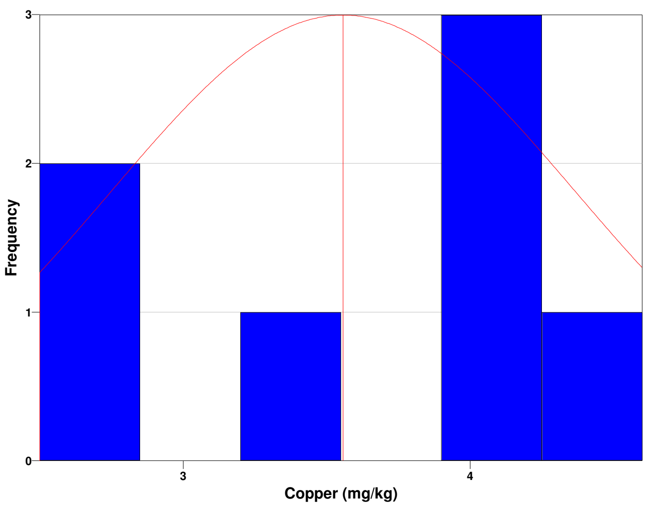
The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 2.5, do appear to follow a normal distribution at the 5% level of significance.

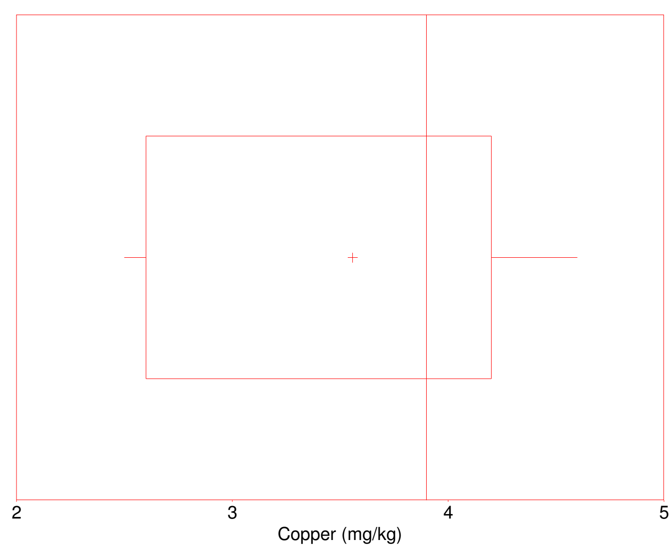
Data Plots for Copper
Graphical displays of the data are shown below.

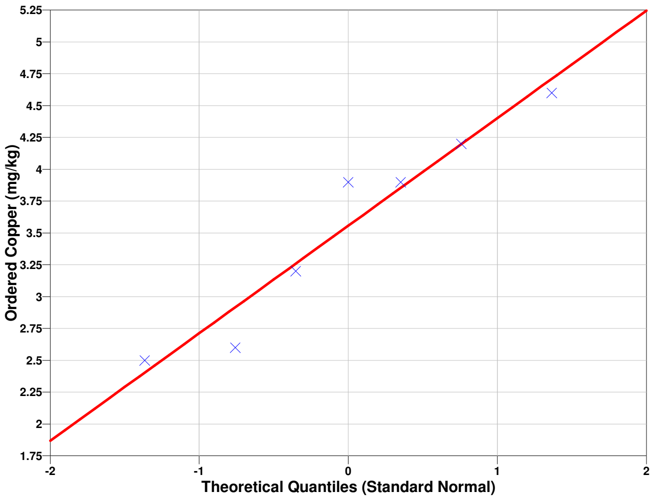
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Copper
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9185
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	4.149
95% Non-Parametric (Chebyshev) UCL	4.885

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (4.149) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1786	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Lead
The following data points were entered by the user for analysis.

Lead (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	3.3	4.5	4.7	5.8	7	7.9	13.5			

SUMMARY STATISTICS for Lead								
n	7							
Min	3.3							
Max	13.5							
Range	10.2							
Mean	6.6714							
Median	5.8							
Variance	11.496							
StdDev	3.3905							
Std Error	1.2815							
Skewness	1.577							
Interquartile Range	3.4							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
3.3	3.3	3.3	4.5	5.8	7.9	13.5	13.5	13.5

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Lead	
Dixon Test Statistic	0.11765
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 3.3 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8277
Shapiro-Wilk 5% Critical Value	0.788

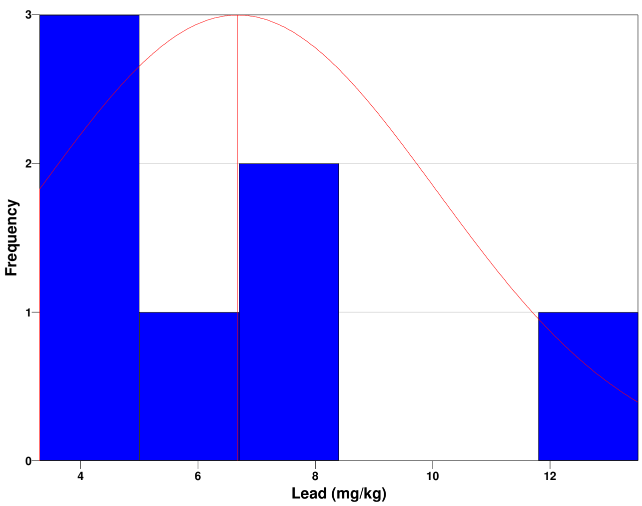
The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 3.3, do appear to follow a normal distribution at the 5% level of significance.

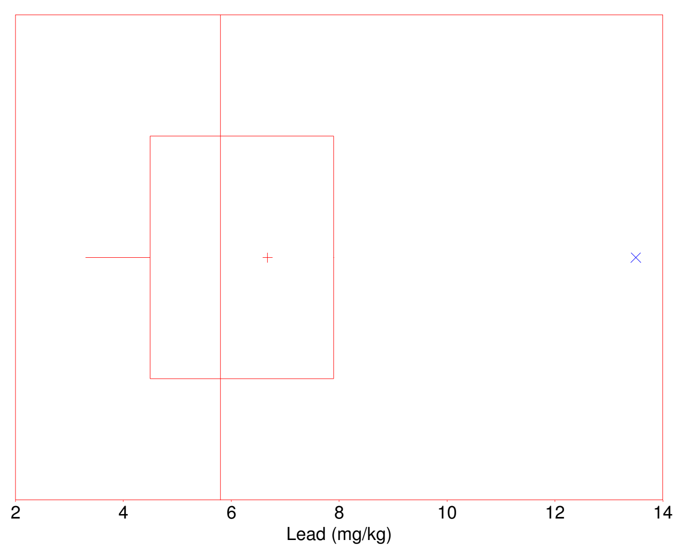
Data Plots for Lead
Graphical displays of the data are shown below.

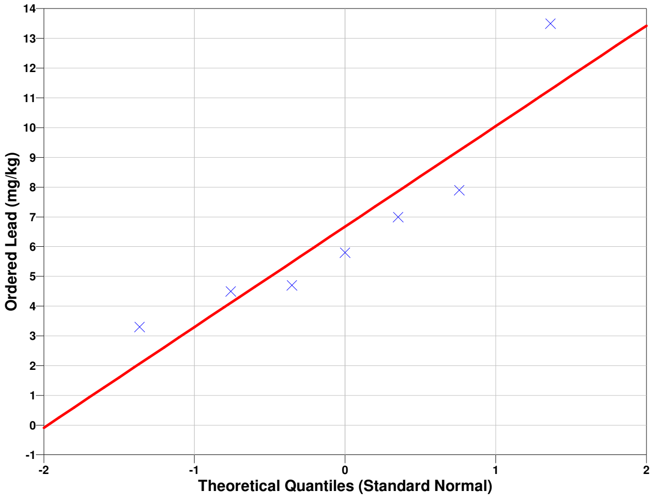
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Lead
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8619
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	9.162
95% Non-Parametric (Chebyshev) UCL	12.26

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (9.162) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-306.93	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Manganese
The following data points were entered by the user for analysis.

Manganese (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	53.3	78.7	84.5	95.9	100	113	226			

SUMMARY STATISTICS for Manganese								
n	7							
Min	53.3							
Max	226							
Range	172.7							
Mean	107.34							
Median	95.9							
Variance	3093.2							
StdDev	55.617							
Std Error	21.021							
Skewness	2.0015							
Interquartile Range	34.3							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
53.3	53.3	53.3	78.7	95.9	113	226	226	226

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Manganese	
Dixon Test Statistic	0.14708
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 53.3 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7013
Shapiro-Wilk 5% Critical Value	0.788

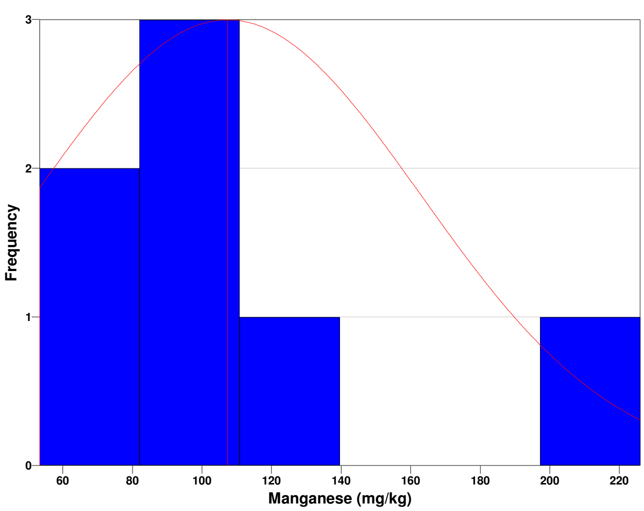
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 53.3, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

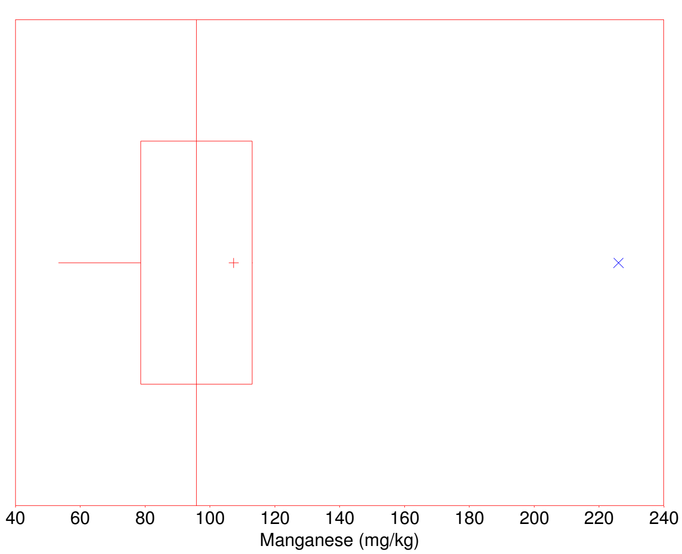
Data Plots for Manganese
Graphical displays of the data are shown below.

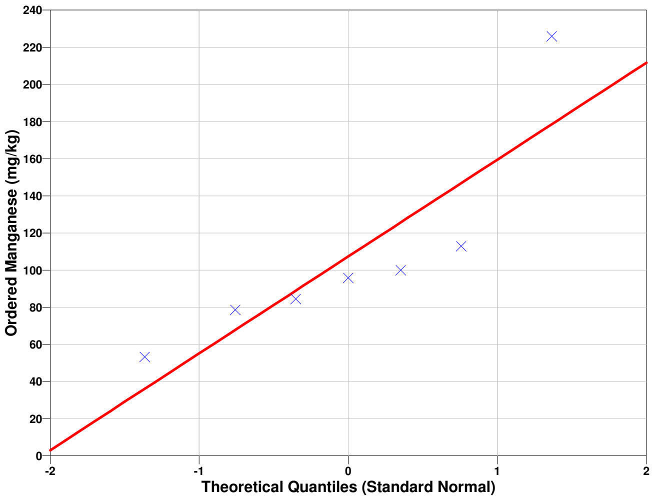
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Manganese
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7786
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	148.2
95% Non-Parametric (Chebyshev) UCL	199

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (199) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-148.99	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Data Analysis for Mercury
The following data points were entered by the user for analysis.

Mercury (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0049	0.008	0.008	0.0087	0.014	0.018	0.022			

SUMMARY STATISTICS for Mercury								
n	7							
Min	0.0049							
Max	0.022							
Range	0.0171							
Mean	0.011943							
Median	0.0087							
Variance	3.888e-005							
StdDev	0.0062353							
Std Error	0.0023567							
Skewness	0.7143							
Interquartile Range	0.01							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0049	0.0049	0.0049	0.008	0.0087	0.018	0.022	0.022	0.022

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible

explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Mercury	
Dixon Test Statistic	0.18129
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.0049 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8587
Shapiro-Wilk 5% Critical Value	0.788

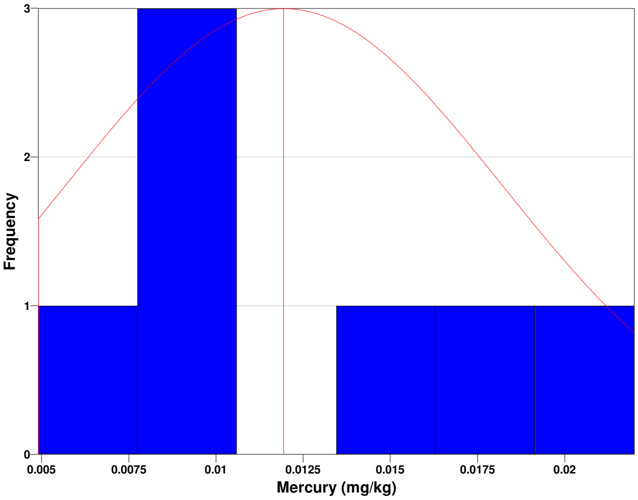
The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.0049, do appear to follow a normal distribution at the 5% level of significance.

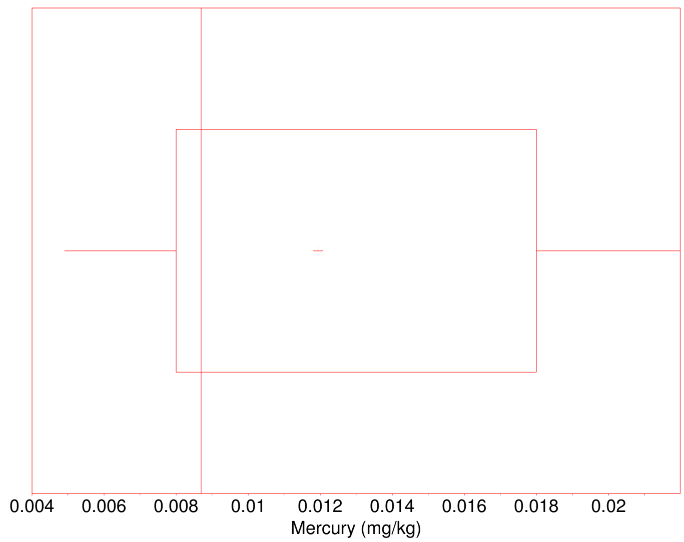
Data Plots for Mercury
Graphical displays of the data are shown below.

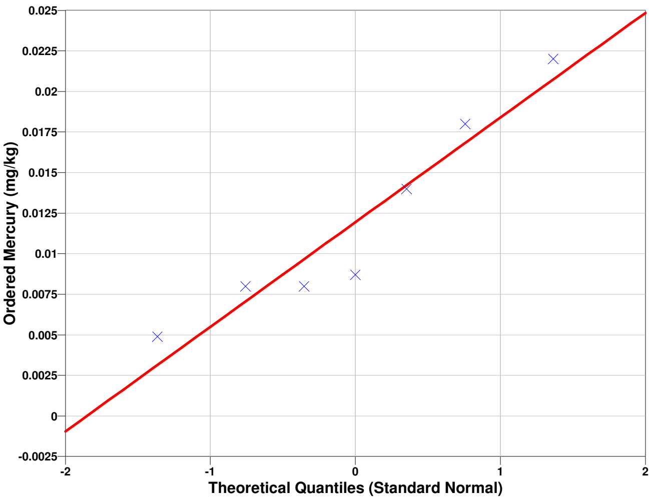
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Mercury
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.905
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.01652

95% Non-Parametric (Chebyshev) UCL	0.02222

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0.01652) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-880.58	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Nickel
The following data points were entered by the user for analysis.

Nickel (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.59	1.7	1.8	2	2.1	2.15	2.5			

SUMMARY STATISTICS for Nickel								
n	7							
Min	0.59							
Max	2.5							
Range	1.91							
Mean	1.8343							
Median	2							
Variance	0.36806							
StdDev	0.60668							
Std Error	0.2293							
Skewness	-1.6501							
Interquartile Range	0.45							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**

0.59	0.59	0.59	1.7	2	2.15	2.5	2.5	2.5

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Nickel	
Dixon Test Statistic	0.58115
Dixon 5% Critical Value	0.507

The calculated test statistic exceeds the critical value, so the test rejects the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.59 is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Nickel	
Min	0.59

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9605
Shapiro-Wilk 5% Critical Value	0.788

The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.59, do appear to follow a normal distribution at the 5% level of significance.

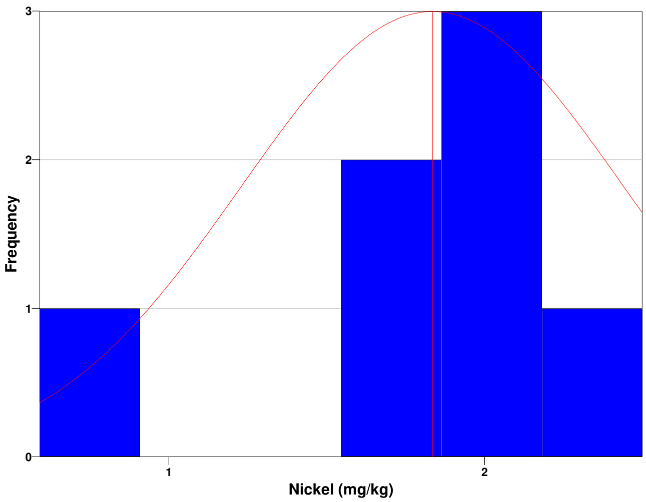
Data Plots for Nickel
Graphical displays of the data are shown below.

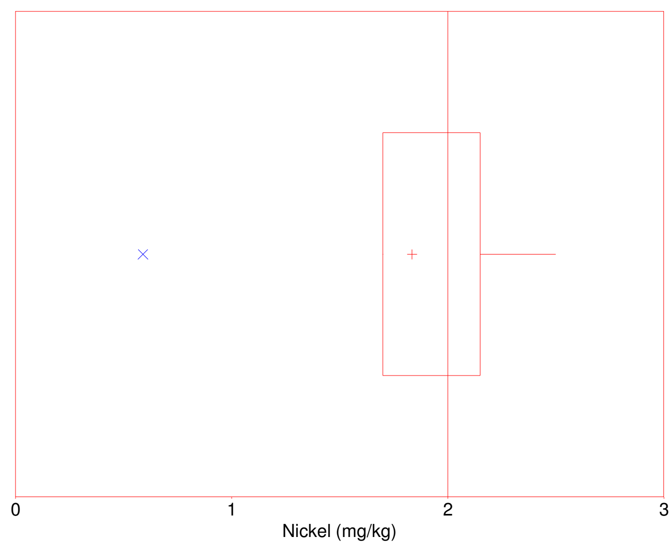
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

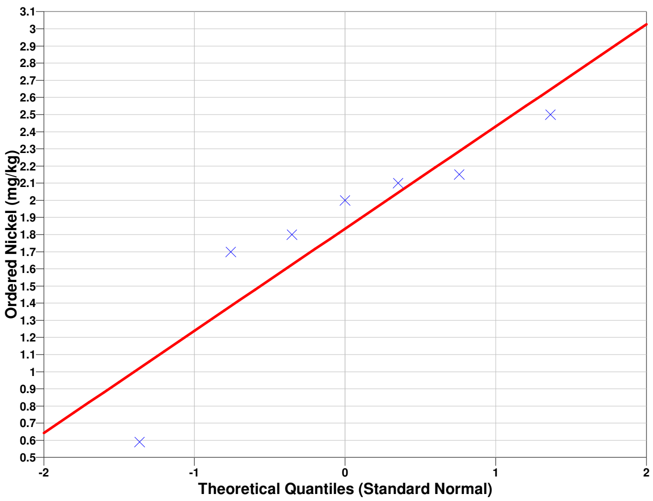
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate

substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Nickel
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8486
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN

95% Parametric UCL	2.28
95% Non-Parametric (Chebyshev) UCL	2.834

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (2.28) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-3620.8	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Vanadium
The following data points were entered by the user for analysis.

Vanadium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	2.5	5.5	6.1	6.2	6.3	6.5	8.4			

SUMMARY STATISTICS for Vanadium	
n	7
Min	2.5
Max	8.4
Range	5.9
Mean	5.9286
Median	6.2
Variance	3.1024
StdDev	1.7614
Std Error	0.66573
Skewness	-1.0685
Interquartile Range	1
Percentiles	

1%	5%	10%	25%	50%	75%	90%	95%	99%
2.5	2.5	2.5	5.5	6.2	6.5	8.4	8.4	8.4

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Vanadium	
Dixon Test Statistic	0.50847
Dixon 5% Critical Value	0.507

The calculated test statistic exceeds the critical value, so the test rejects the null hypothesis that there are no outliers in the data, and concludes that the minimum value 2.5 is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Vanadium	
Min	2.5

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8049
Shapiro-Wilk 5% Critical Value	0.788

The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 2.5, do appear to follow a normal distribution at the 5% level of significance.

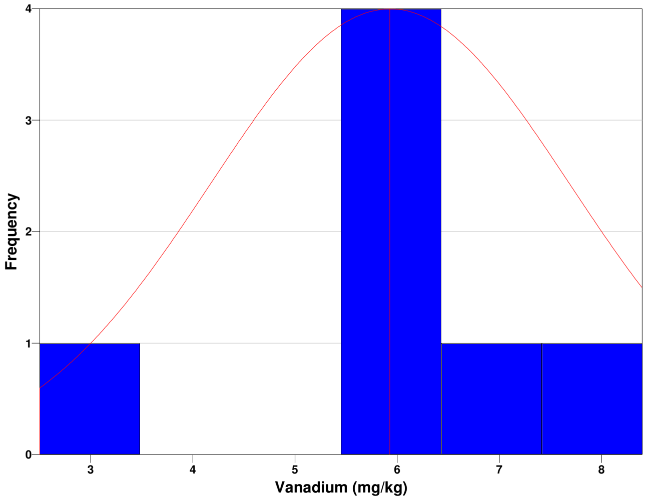
Data Plots for Vanadium
Graphical displays of the data are shown below.

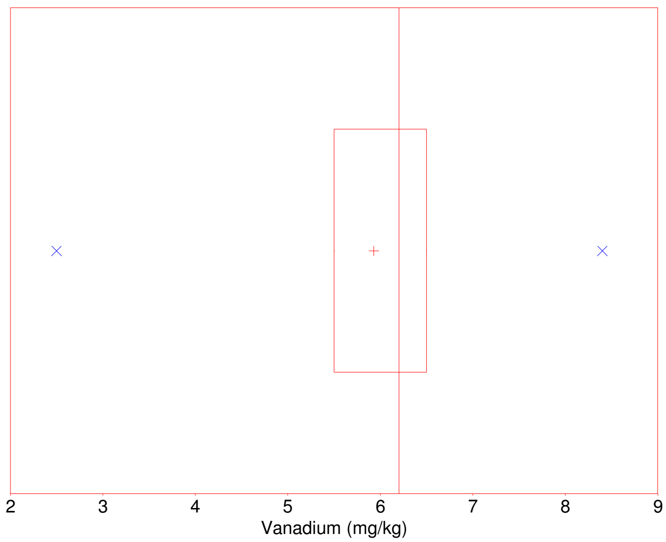
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

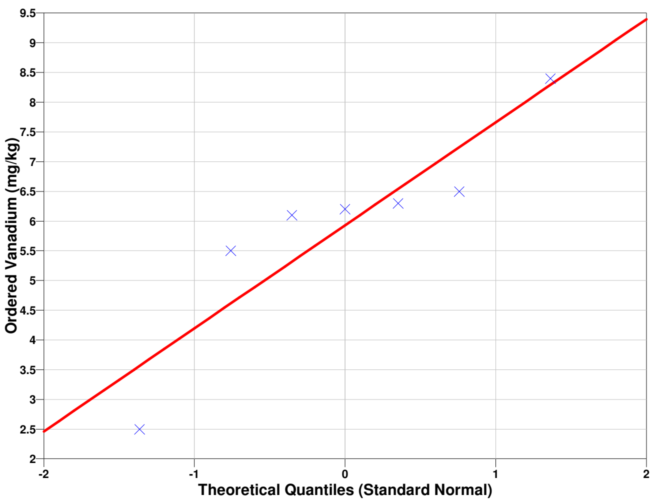
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a

fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Vanadium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8633
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN

95% Parametric UCL	7.222
95% Non-Parametric (Chebyshev) UCL	8.83

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (7.222) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-428.23	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Zinc
The following data points were entered by the user for analysis.

Zinc (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	23.9	32.8	32.9	44	66.6	279	346			

SUMMARY STATISTICS for Zinc	
n	7
Min	23.9
Max	346
Range	322.1
Mean	117.89
Median	44
Variance	18230
StdDev	135.02
Std Error	51.032
Skewness	1.2754
Interquartile Range	246.2
Percentiles	

1%	5%	10%	25%	50%	75%	90%	95%	99%
23.9	23.9	23.9	32.8	44	279	346	346	346

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Zinc	
Dixon Test Statistic	0.027631
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 23.9 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7492
Shapiro-Wilk 5% Critical Value	0.788

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 23.9, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

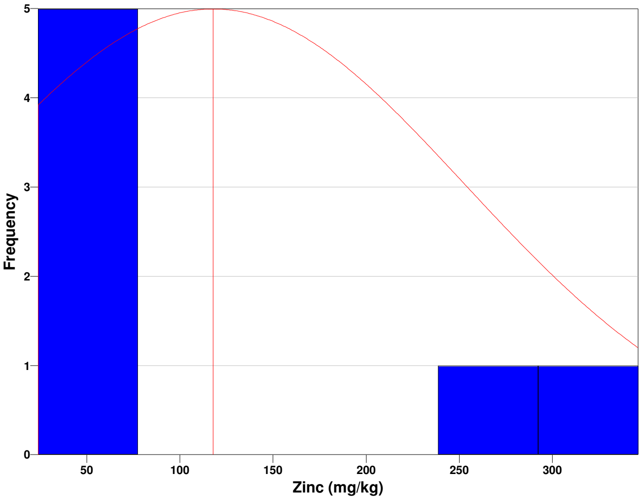
Data Plots for Zinc
Graphical displays of the data are shown below.

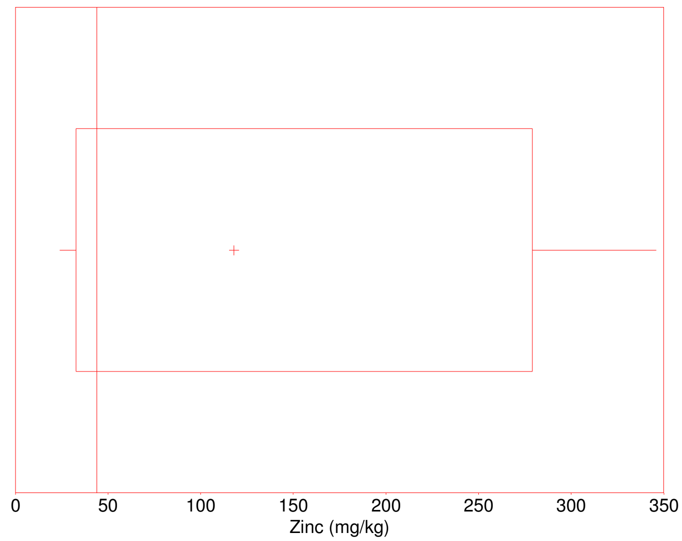
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

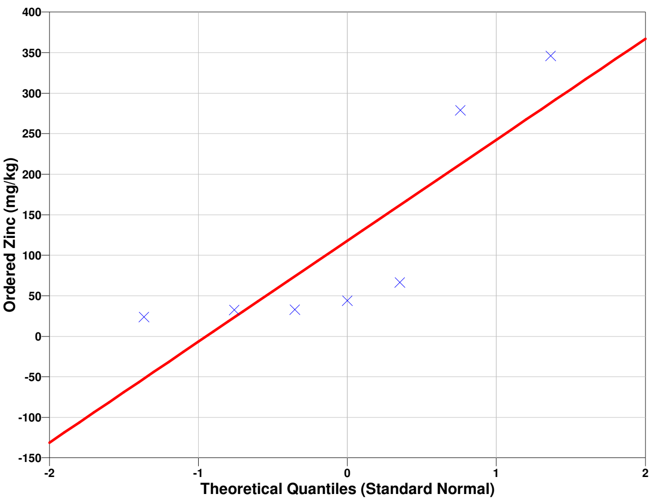
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight

line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Zinc
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7173
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN

95% Parametric UCL	217
95% Non-Parametric (Chebyshev) UCL	340.3

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (340.3) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-192.11	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Data Analysis for Aluminum
The following data points were entered by the user for analysis.

Aluminum (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1760	3420	3590	4390	4420	4590	6020			

SUMMARY STATISTICS for Aluminum	
n	7
Min	1760
Max	6020
Range	4260
Mean	4027.1
Median	4390

Variance	1.7123e+006
StdDev	1308.6
Std Error	494.59
Skewness	-0.39144
Interquartile Range	1170

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
1760	1760	1760	3420	4390	4590	6020	6020	6020

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Aluminum	
Dixon Test Statistic	0.38967
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 1760 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8938
Shapiro-Wilk 5% Critical Value	0.788

The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 1760, do appear to follow a normal distribution at the 5% level of significance.

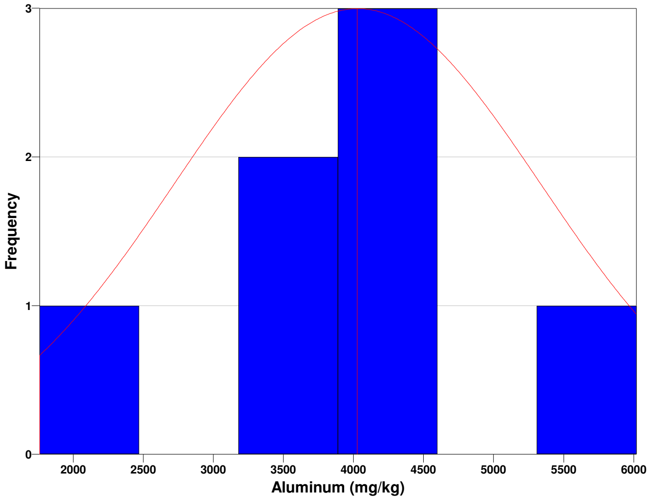
Data Plots for Aluminum
Graphical displays of the data are shown below.

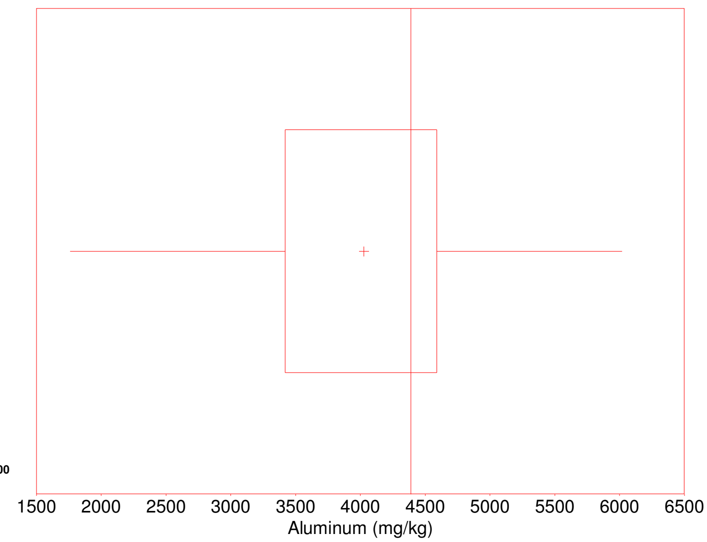
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

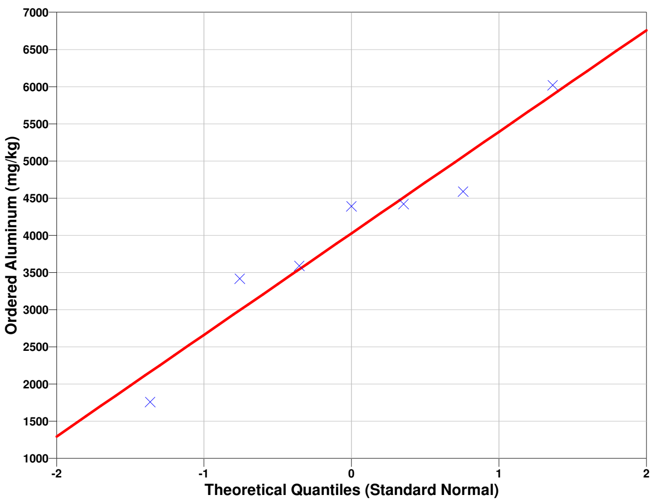
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the

distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Aluminum

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9512
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	4988
95% Non-Parametric (Chebyshev) UCL	6183

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (4988) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-5.0426	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Appendix C

VSP Reports of Calculated Minimum Sample Quantity
Report 13
Area of Concern – 3
Minimum Sample Quantity Calculation for Surface Soil using Ecological Benchmarks and Delta Method 1

Random sampling locations for comparing a mean with a fixed threshold (parametric)

Summary
This report summarizes the sampling design, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design for Zinc, the driving analyte (the analyte which required the largest number of samples). A figure that shows sampling locations in the field is also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean to a fixed threshold
Type of Sampling Design	Parametric
Sample Placement (Location) in the Field	Simple random sampling
Working (Null) Hypothesis	The mean value at the site exceeds the threshold
Formula for calculating number of sampling locations	Student's t-test
Calculated total number of samples	34926
Number of samples on map [a]	10000
Number of selected sample areas [b]	1
Specified sampling area [c]	602117.04 m^2
Total cost of sampling [d]	$17,464,000.00

[a] This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[d] Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.

Primary Sampling Objective
The primary purpose of sampling at this site is to compare a mean value of a site with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the mean value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the mean value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative hypothesis, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach
A parametric random sampling approach was used to determine the number of samples and to specify sampling locations. A parametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that parametric assumptions are reasonable. These assumptions will be examined in post-sampling data analysis.

Both parametric and non-parametric approaches rely on assumptions about the population. However, non-parametric

approaches typically require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than the number of samples required by non-parametric approaches.

Locating the sample points randomly provides data that are separated by many distances, whereas systematic samples are all equidistant apart. Therefore, random sampling provides more information about the spatial structure of the potential contamination than systematic sampling does. As with systematic sampling, random sampling also provides information regarding the mean value, but there is the possibility that areas of the site will not be represented with the same frequency as if uniform grid sampling were performed.

Number of Total Samples: Calculation Equation and Inputs
The equation used to calculate the number of samples is based on a Student's t-test. For this site, the null hypothesis is rejected in favor of the alternative hypothesis if the sample mean is sufficiently smaller than the threshold. The number of samples to collect is calculated so that 1) there will be a high probability (1-β) of rejecting the null hypothesis if the alternative hypothesis is true and 2) a low probability (α) of rejecting the null hypothesis if the null hypothesis is true.

The formula used to calculate the number of samples is:

$$n = \frac{S^2}{\Delta^2}\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2 + 0.5Z_{1-\alpha}^2$$

where
n is the number of samples,
S is the estimated standard deviation of the measured values including analytical error,
Δ is the width of the gray region,
α is the acceptable probability of incorrectly concluding the site mean is less than the threshold,
β is the acceptable probability of incorrectly concluding the site mean exceeds the threshold,
$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is 1-α,
$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is 1-β.

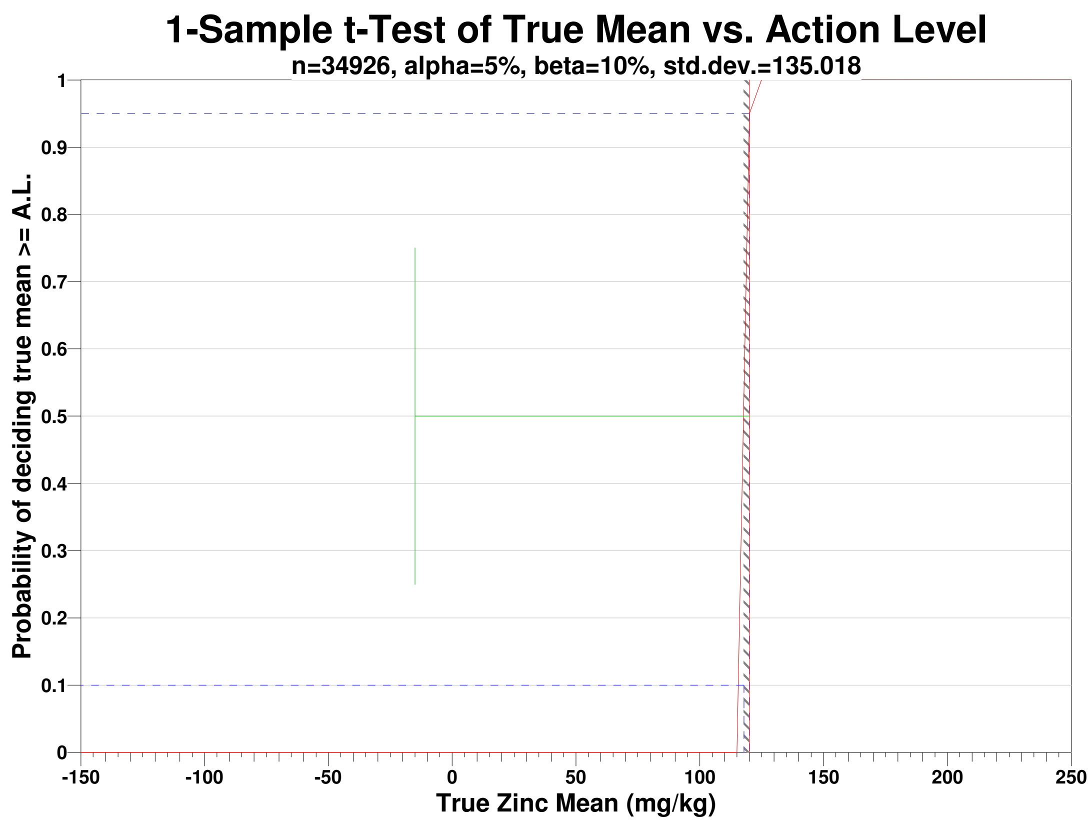
The values of these inputs that result in the calculated number of sampling locations are:

Analyte	**n**	**Parameter**					
		S	**Δ**	**α**	**β**	**$Z_{1-\alpha}$** [a]	**$Z_{1-\beta}$** [b]
New Location	2	0.1 mg/kg	10 mg/kg	0.05	0.1	1.64485	1.28155
Arsenic	2	0.594389 mg/kg	16.8221 mg/kg	0.05	0.1	1.64485	1.28155
Barium	21	209.832 mg/kg	140.3 mg/kg	0.05	0.1	1.64485	1.28155
Beryllium	2	0.056614 mg/kg	9.82086 mg/kg	0.05	0.1	1.64485	1.28155
Chromium	3	1.43858 mg/kg	3.64286 mg/kg	0.05	0.1	1.64485	1.28155
Cobalt	2	0.313741 mg/kg	12.02 mg/kg	0.05	0.1	1.64485	1.28155
Copper	2	0.80593 mg/kg	57.4429 mg/kg	0.05	0.1	1.64485	1.28155
Lead	2	3.39053 mg/kg	113.329 mg/kg	0.05	0.1	1.64485	1.28155
Manganese	2	55.6166 mg/kg	392.657 mg/kg	0.05	0.1	1.64485	1.28155
Mercury	2	0.00623534 mg/kg	0.0880571 mg/kg	0.05	0.1	1.64485	1.28155
Nickel	2	0.606681 mg/kg	28.1657 mg/kg	0.05	0.1	1.64485	1.28155
Vanadium	4	1.76136 mg/kg	3.92857 mg/kg	0.05	0.1	1.64485	1.28155
Zinc	34926	135.018 mg/kg	2.11429 mg/kg	0.05	0.1	1.64485	1.28155

[a] This value is automatically calculated by VSP based upon the user defined value of α.
[b] This value is automatically calculated by VSP based upon the user defined value of β.

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000) for Zinc, the driving analyte. It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true mean values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at 1-α on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at 1-α. If any of the inputs change, the number of samples that result in the correct curve changes.



Statistical Assumptions

The assumptions associated with the formulas for computing the number of samples are:

1. the sample mean is normally distributed (this happens if the data are roughly symmetric or the sample size is more than 30; for extremely skewed data sets, additional samples may be required for the sample mean to be normally distributed),
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected randomly.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the sample locations were selected using a random process.

Sensitivity Analysis

The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that μ > action level and alpha (%), probability of mistakenly concluding that μ < action level. The following table shows the results of this analysis.

Number of Samples							
AL=120		α=5		α=10		α=15	
		s=270.036	s=135.018	s=270.036	s=135.018	s=270.036	s=135.018
LBGR=90	β=5	5482	1372	4338	1085	3642	911

	β=10	4338	1086	3328	833	2722	681
	β=15	3642	912	2722	682	2177	545
LBGR=80	β=5	1372	344	1085	272	911	229
	β=10	1086	273	833	209	681	171
	β=15	912	229	682	171	545	137
LBGR=70	β=5	611	154	483	122	406	102
	β=10	484	122	371	94	303	77
	β=15	406	103	304	77	243	61

s = Standard Deviation
LBGR = Lower Bound of Gray Region (% of Action Level)
β = Beta (%), Probability of mistakenly concluding that μ > action level
α = Alpha (%), Probability of mistakenly concluding that μ < action level
AL = Action Level (Threshold)

Cost of Sampling
The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that are based on the number of samples collected and measured. Based on the numbers of samples determined above, the estimated total cost of sampling and analysis at this site is $17,464,000.00, which averages out to a per sample cost of $500.03. The following table summarizes the inputs and resulting cost estimates.

COST INFORMATION			
Cost Details	**Per Analysis**	**Per Sample**	**34926 Samples**
Field collection costs		$100.00	$3,492,600.00
Analytical costs	$400.00	$400.00	$13,970,400.00
Sum of Field & Analytical costs		**$500.00**	**$17,463,000.00**
Fixed planning and validation costs			$1,000.00
Total cost			**$17,464,000.00**

Data Analysis for New Location

SUMMARY STATISTICS for New Location								
n				9993				
Min				0				
Max				0				
Range				0				
Mean				0				
Median				0				
Variance				0				
StdDev				0				
Std Error				0				
Skewness				-1.#IND				
Interquartile Range				0				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**

0	0	0	0	0	0	0	0	0	0

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for New Location			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	-1.#IO	3.83	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Lilliefors test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Lilliefors Test Statistic	0
Lilliefors 5% Critical Value	0.04238

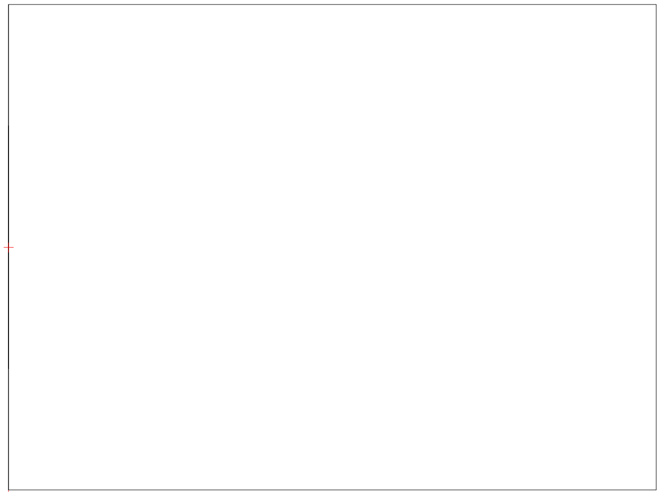
The calculated Lilliefors test statistic is less than the 5% Lilliefors critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do appear to follow a normal distribution at the 5% level of significance.

Data Plots for New Location
Graphical displays of the data are shown below.

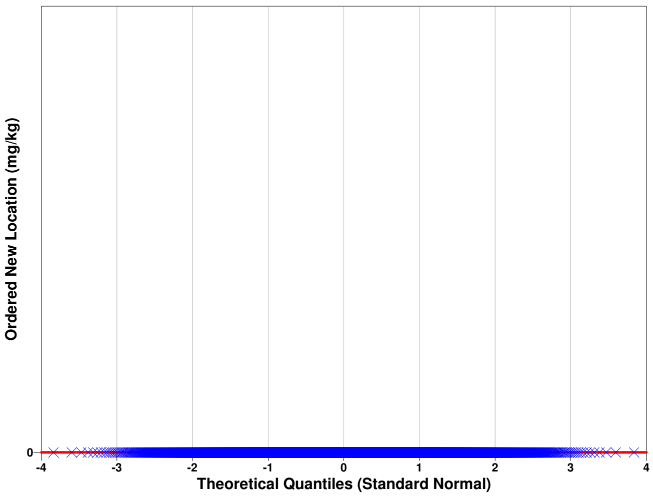
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.



New Location (mg/kg)



For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for New Location

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Lilliefors test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Lilliefors Test Statistic	0
Lilliefors 5% Critical Value	0.008863

The calculated Lilliefors test statistic is less than the 5% Lilliefors critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0

95% Non-Parametric (Chebyshev) UCL	0

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=9993 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=9992 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.#IND	1.645	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Data Analysis for Arsenic
The following data points were entered by the user for analysis.

Arsenic (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.72	0.96	0.965	1	1	1.1	2.5			

SUMMARY STATISTICS for Arsenic								
n	7							
Min	0.72							
Max	2.5							
Range	1.78							
Mean	1.1779							
Median	1							
Variance	0.3533							
StdDev	0.59439							
Std Error	0.22466							
Skewness	2.4261							
Interquartile Range	0.14							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**

0.72	0.72	0.72	0.96	1	1.1	2.5	2.5	2.5

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Arsenic	
Dixon Test Statistic	0.13483
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.72 is not an outlier at the 10% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5638
Shapiro-Wilk 10% Critical Value	0.826

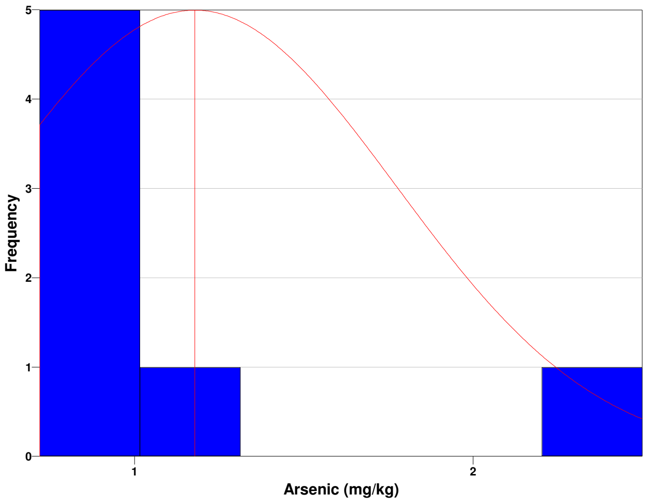
The calculated Shapiro-Wilk test statistic is less than the 10% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.72, do not appear to follow a normal distribution at the 10% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

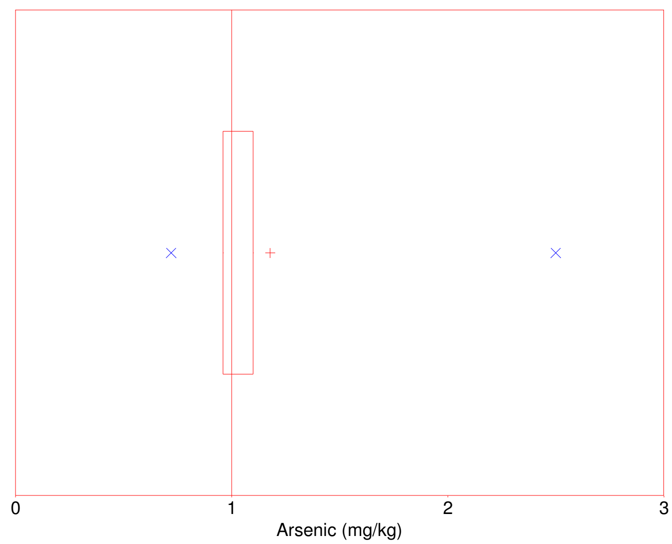
Data Plots for Arsenic
Graphical displays of the data are shown below.

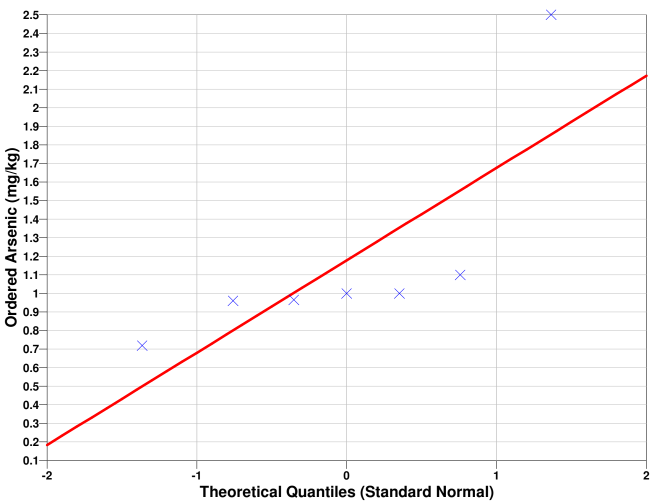
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Arsenic
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6313
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	1.614

95% Non-Parametric (Chebyshev) UCL	2.157

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (2.157) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-74.879	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Data Analysis for Barium
The following data points were entered by the user for analysis.

Barium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	16.6	37.9	74.4	139	206	224	630			

SUMMARY STATISTICS for Barium	
n	7
Min	16.6
Max	630
Range	613.4
Mean	189.7
Median	139
Variance	44030

StdDev				209.83				
Std Error				79.309				
Skewness				1.8956				
Interquartile Range				186.1				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
16.6	16.6	16.6	37.9	139	224	630	630	630

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Barium	
Dixon Test Statistic	0.034724
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 16.6 is not an outlier at the 10% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8015
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic is less than the 10% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 16.6, do not appear to follow a normal distribution at the 10% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

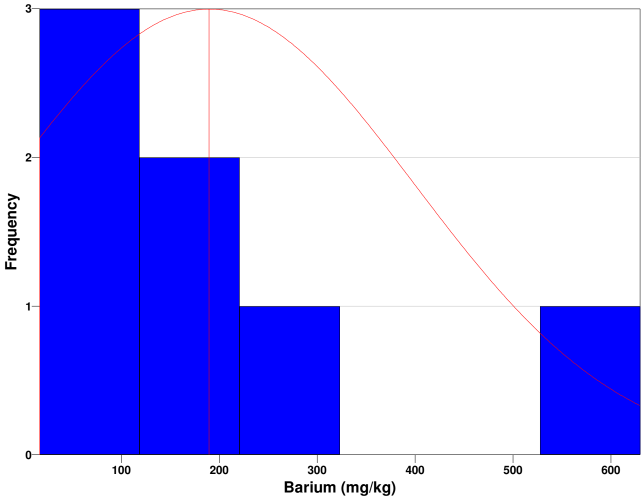
Data Plots for Barium
Graphical displays of the data are shown below.

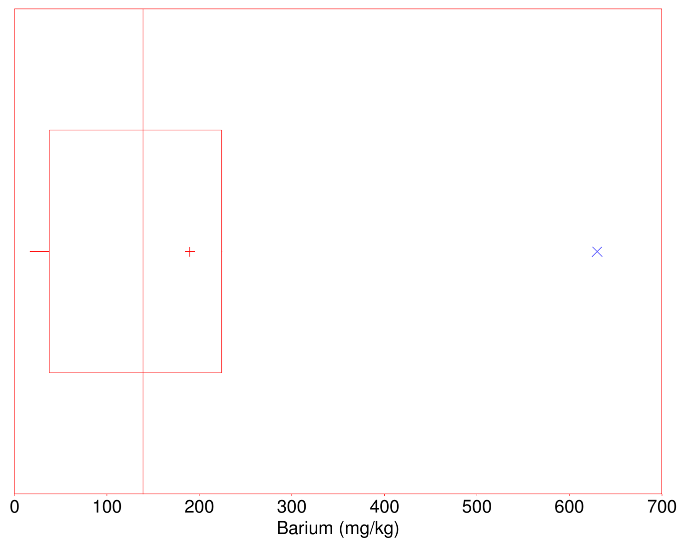
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

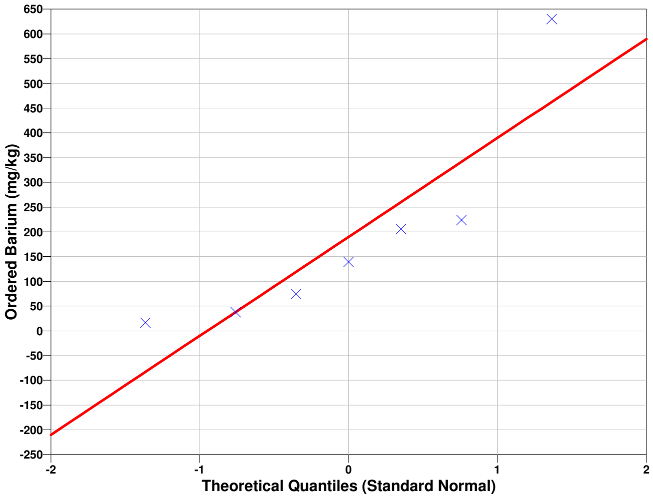
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted

individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Barium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7912
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance.

The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	343.8
95% Non-Parametric (Chebyshev) UCL	535.4

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (535.4) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.769	1.9432	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
6	6	Cannot Reject
Note: There may not be enough data to reject the null hypothesis (and conclude site is clean) with 95% confidence using the MARSSIM sign test.		

Data Analysis for Beryllium
The following data points were entered by the user for analysis.

Beryllium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.074	0.15	0.17	0.18	0.21	0.23	0.24			

SUMMARY STATISTICS for Beryllium								
n				7				
Min				0.074				
Max				0.24				
Range				0.166				
Mean				0.17914				
Median				0.18				
Variance				0.0032051				
StdDev				0.056614				
Std Error				0.021398				
Skewness				-1.0307				
Interquartile Range				0.08				
Percentiles								
1%	5%	10%	25%	50%	75%	90%	95%	99%
0.074	0.074	0.074	0.15	0.18	0.23	0.24	0.24	0.24

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Beryllium	
Dixon Test Statistic	0.45783
Dixon 10% Critical Value	0.434

The calculated test statistic exceeds the critical value, so the test rejects the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.074 is an outlier at the 10% significance level.

SUSPECTED OUTLIERS for Beryllium	
Min	0.074

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9444
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.074, do appear to follow a normal distribution at the 10% level of significance.

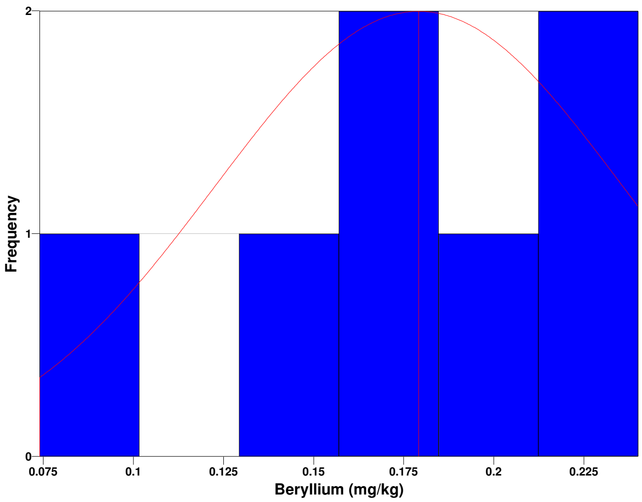
Data Plots for Beryllium
Graphical displays of the data are shown below.

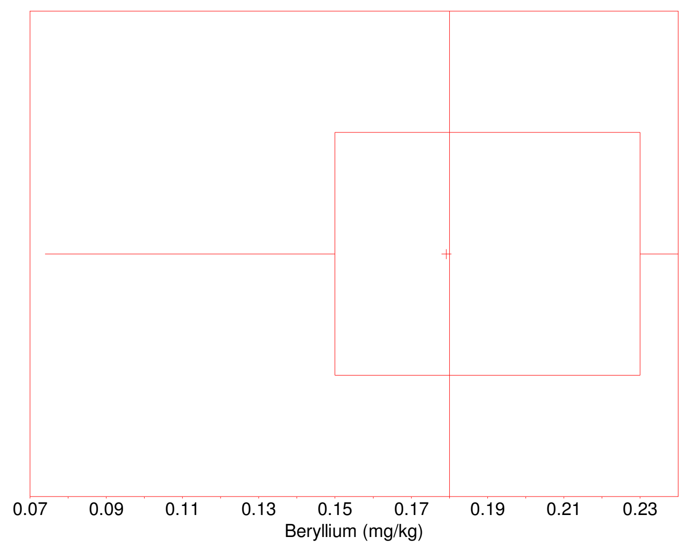
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

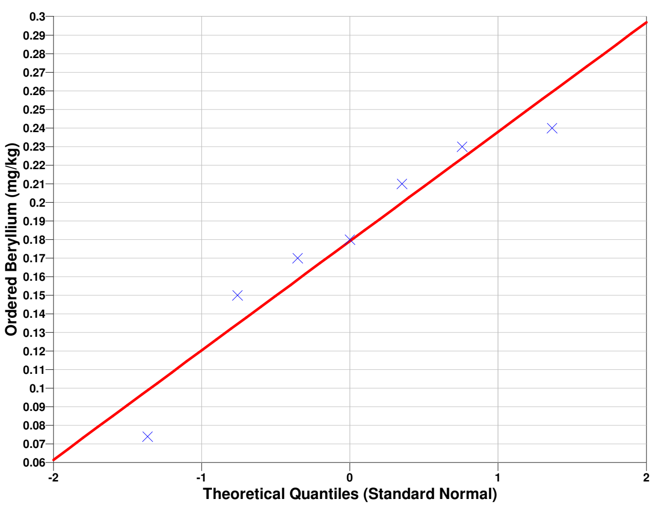
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Beryllium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9243
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.2207
95% Non-Parametric (Chebyshev) UCL	0.2724

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0.2207) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-458.96	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Chromium
The following data points were entered by the user for analysis.

Chromium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1.4	3.5	3.6	4.1	4.8	5	5.9			

SUMMARY STATISTICS for Chromium

n	7
Min	1.4
Max	5.9
Range	4.5
Mean	4.0429
Median	4.1
Variance	2.0695
StdDev	1.4386
Std Error	0.54373
Skewness	-0.86133
Interquartile Range	1.5

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
1.4	1.4	1.4	3.5	4.1	5	5.9	5.9	5.9

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Chromium	
Dixon Test Statistic	0.46667
Dixon 10% Critical Value	0.434

The calculated test statistic exceeds the critical value, so the test rejects the null hypothesis that there are no outliers in the data, and concludes that the minimum value 1.4 is an outlier at the 10% significance level.

SUSPECTED OUTLIERS for Chromium	
Min	1.4

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9348
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 1.4, do appear to follow a normal distribution at the 10% level of significance.

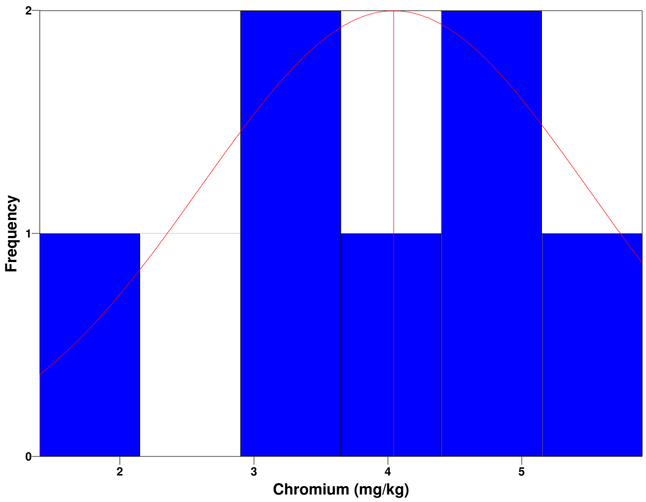
Data Plots for Chromium
Graphical displays of the data are shown below.

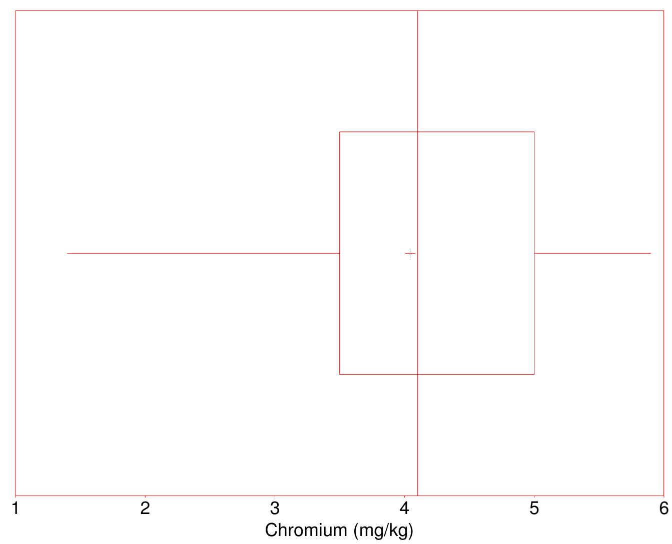
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each

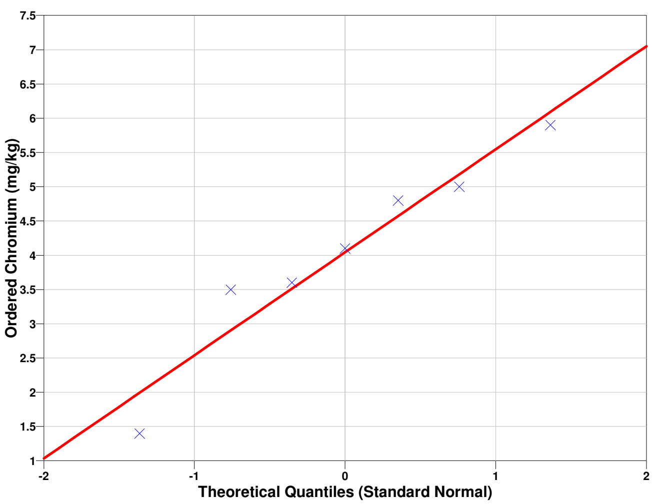
bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Chromium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9462
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	5.099
95% Non-Parametric (Chebyshev) UCL	6.413

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (5.099) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
6.6997	1.9432	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Data Analysis for Cobalt
The following data points were entered by the user for analysis.

Cobalt (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.36	0.92	0.93	1	1.1	1.2	1.35			

SUMMARY STATISTICS for Cobalt

n				7				
Min				0.36				
Max				1.35				
Range				0.99				
Mean				0.98				
Median				1				
Variance				0.098433				
StdDev				0.31374				
Std Error				0.11858				
Skewness				-1.327				
Interquartile Range				0.28				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.36	0.36	0.36	0.92	1	1.2	1.35	1.35	1.35

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Cobalt	
Dixon Test Statistic	0.56566
Dixon 10% Critical Value	0.434

The calculated test statistic exceeds the critical value, so the test rejects the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.36 is an outlier at the 10% significance level.

SUSPECTED OUTLIERS for Cobalt	
Min	0.36

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9171
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.36, do appear to follow a normal distribution at the 10% level of significance.

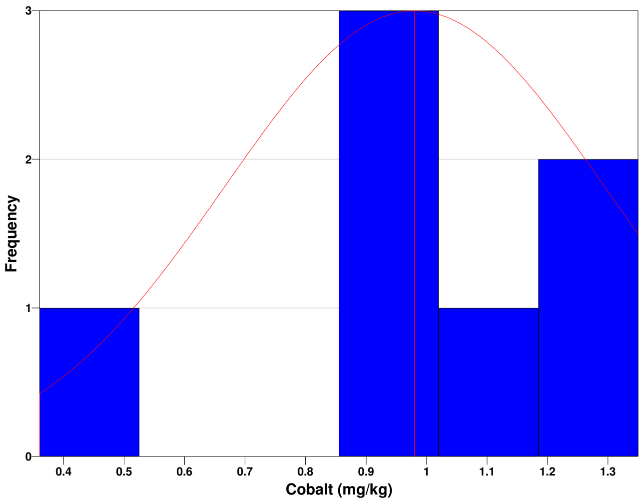
Data Plots for Cobalt
Graphical displays of the data are shown below.

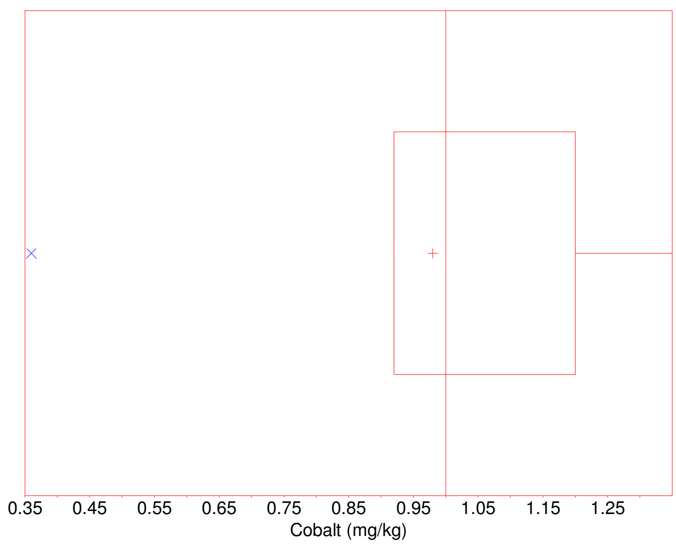
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each

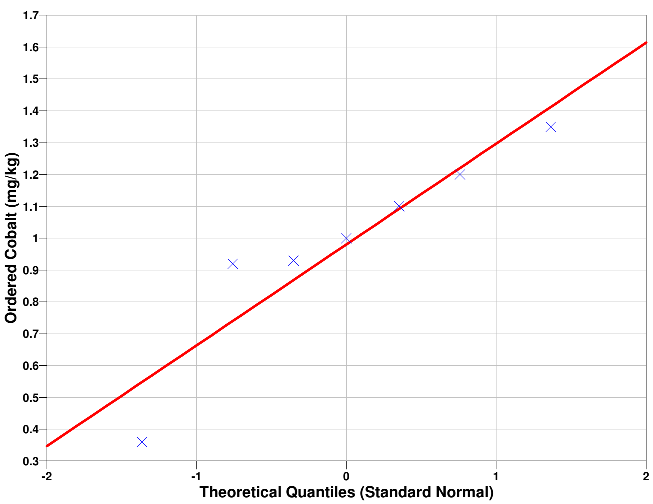
bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Cobalt
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8918
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	1.21
95% Non-Parametric (Chebyshev) UCL	1.497

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (1.21) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-101.36	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Copper
The following data points were entered by the user for analysis.

Copper (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	2.5	2.6	3.2	3.9	3.9	4.2	4.6			

SUMMARY STATISTICS for Copper

n				7				
Min				2.5				
Max				4.6				
Range				2.1				
Mean				3.5571				
Median				3.9				
Variance				0.64952				
StdDev				0.80593				
Std Error				0.30461				
Skewness				-0.27787				
Interquartile Range				1.6				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
2.5	2.5	2.5	2.6	3.9	4.2	4.6	4.6	4.6

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Copper	
Dixon Test Statistic	0.047619
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 2.5 is not an outlier at the 10% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9466
Shapiro-Wilk 10% Critical Value	0.826

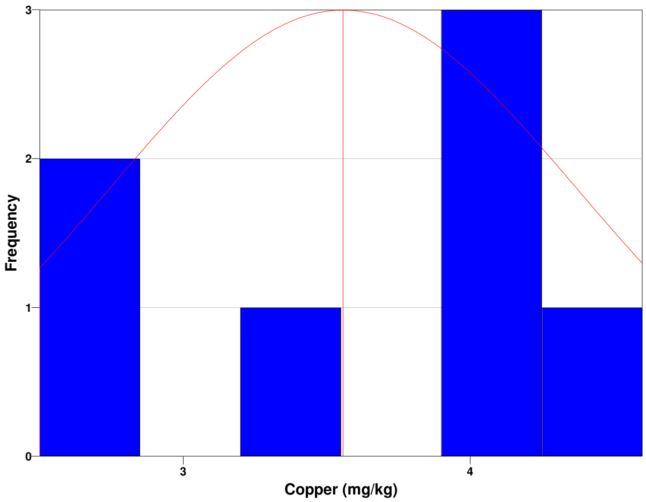
The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 2.5, do appear to follow a normal distribution at the 10% level of significance.

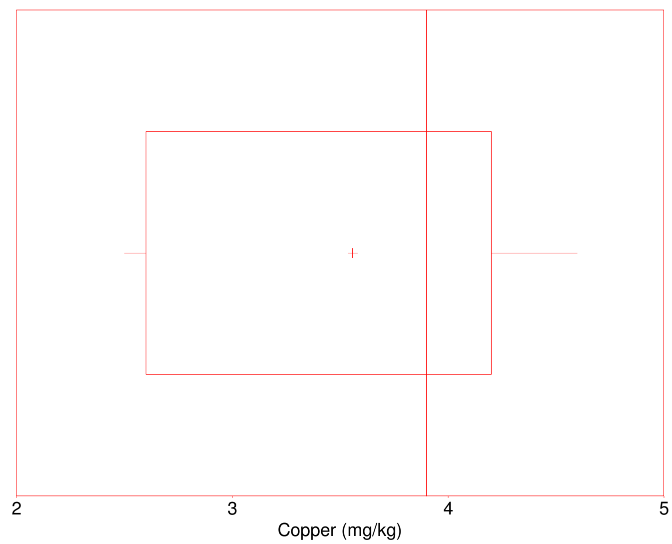
Data Plots for Copper
Graphical displays of the data are shown below.

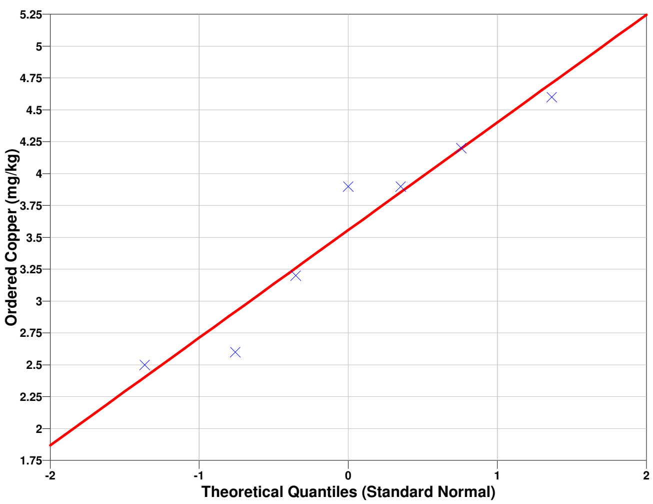
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Copper
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST

Shapiro-Wilk Test Statistic	0.9185
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	4.149
95% Non-Parametric (Chebyshev) UCL	4.885

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (4.149) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-188.58	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Lead
The following data points were entered by the user for analysis.

Lead (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	3.3	4.5	4.7	5.8	7	7.9	13.5			

SUMMARY STATISTICS for Lead	
n	7
Min	3.3
Max	13.5

Range				10.2				
Mean				6.6714				
Median				5.8				
Variance				11.496				
StdDev				3.3905				
Std Error				1.2815				
Skewness				1.577				
Interquartile Range				3.4				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
3.3	3.3	3.3	4.5	5.8	7.9	13.5	13.5	13.5

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Lead	
Dixon Test Statistic	0.11765
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 3.3 is not an outlier at the 10% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8277
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 3.3, do appear to follow a normal distribution at the 10% level of significance.

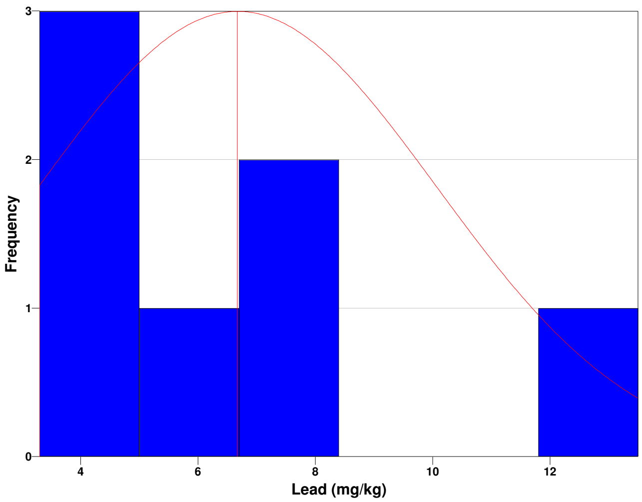
Data Plots for Lead
Graphical displays of the data are shown below.

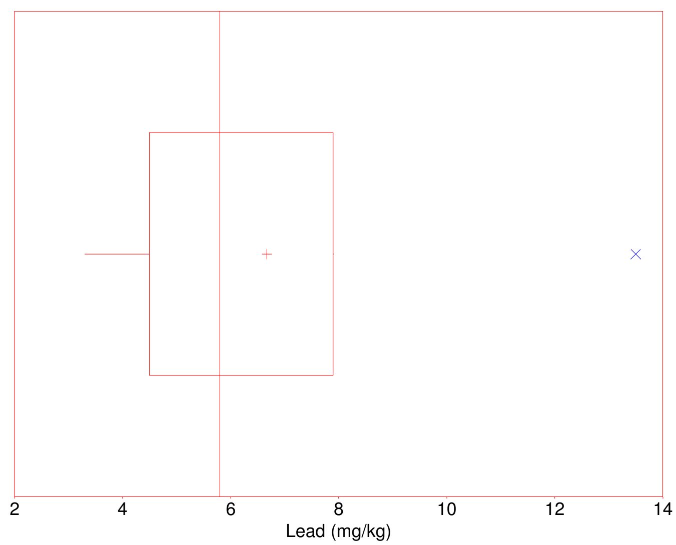
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

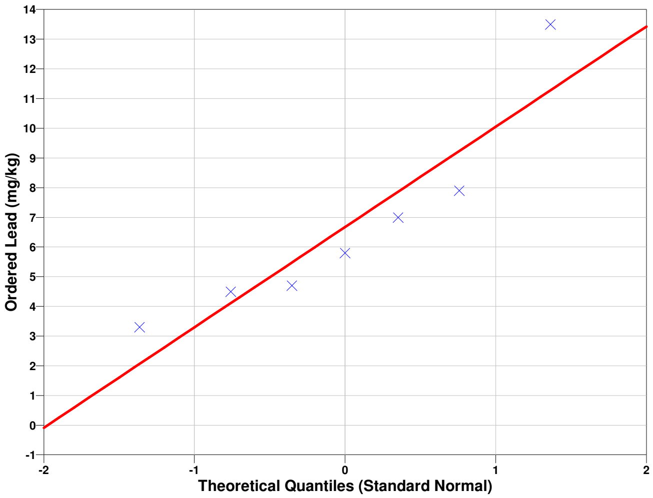
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends

to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Lead

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8619
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	9.162
95% Non-Parametric (Chebyshev) UCL	12.26

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (9.162) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test

A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where

x is the sample mean of the n=7 data,

AL is the action level or threshold (120),

SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-88.434	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Manganese

The following data points were entered by the user for analysis.

Manganese (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	53.3	78.7	84.5	95.9	100	113	226			

SUMMARY STATISTICS for Manganese	
n	7
Min	53.3
Max	226
Range	172.7
Mean	107.34

Median	95.9
Variance	3093.2
StdDev	55.617
Std Error	21.021
Skewness	2.0015
Interquartile Range	34.3

Percentiles

1%	5%	10%	25%	50%	75%	90%	95%	99%
53.3	53.3	53.3	78.7	95.9	113	226	226	226

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Manganese	
Dixon Test Statistic	0.14708
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 53.3 is not an outlier at the 10% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7013
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic is less than the 10% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 53.3, do not appear to follow a normal distribution at the 10% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

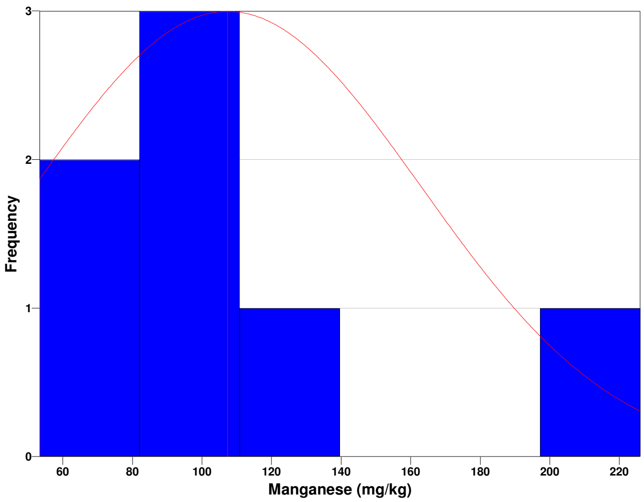
Data Plots for Manganese
Graphical displays of the data are shown below.

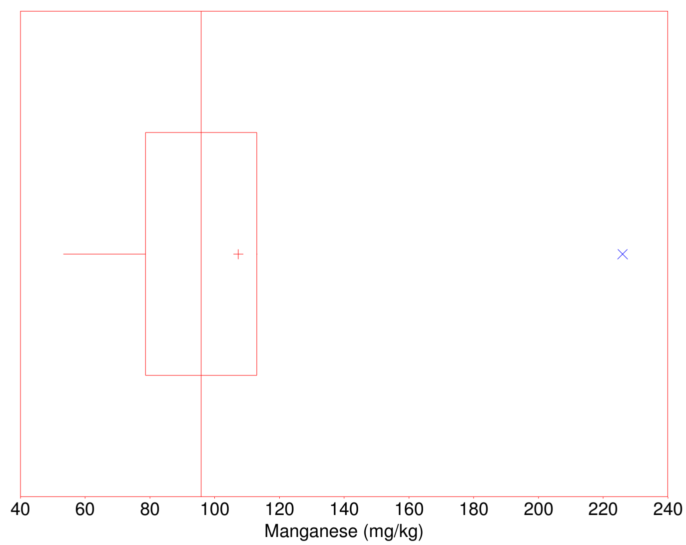
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

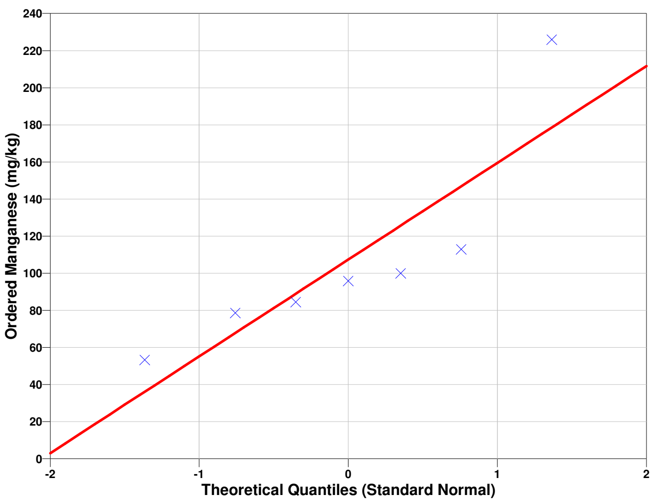
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends

to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Manganese
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7786
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	148.2
95% Non-Parametric (Chebyshev) UCL	199

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (199) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-18.679	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Data Analysis for Mercury
The following data points were entered by the user for analysis.

Mercury (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0049	0.008	0.008	0.0087	0.014	0.018	0.022			

SUMMARY STATISTICS for Mercury

n				7				
Min				0.0049				
Max				0.022				
Range				0.0171				
Mean				0.011943				
Median				0.0087				
Variance				3.888e-005				
StdDev				0.0062353				
Std Error				0.0023567				
Skewness				0.7143				
Interquartile Range				0.01				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0049	0.0049	0.0049	0.008	0.0087	0.018	0.022	0.022	0.022

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Mercury	
Dixon Test Statistic	0.18129
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.0049 is not an outlier at the 10% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8587
Shapiro-Wilk 10% Critical Value	0.826

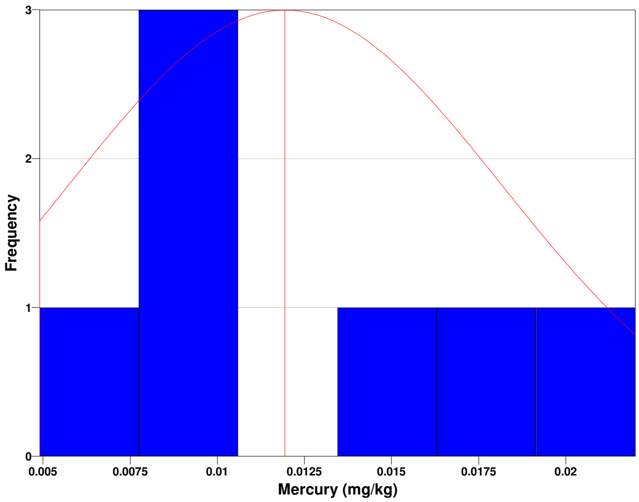
The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.0049, do appear to follow a normal distribution at the 10% level of significance.

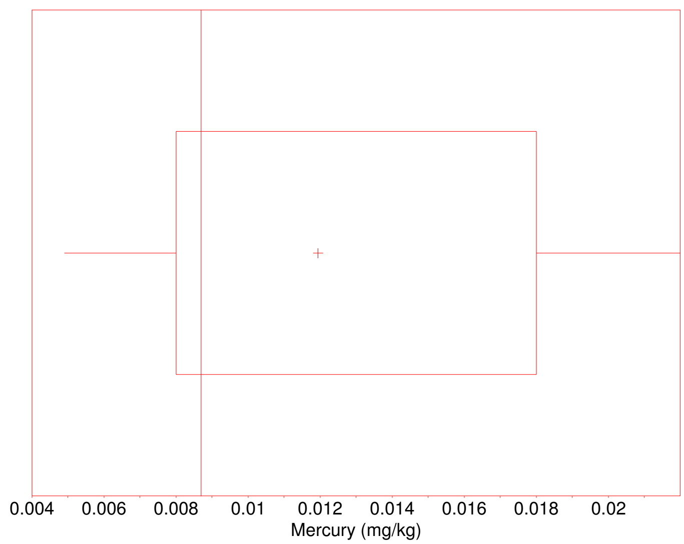
Data Plots for Mercury
Graphical displays of the data are shown below.

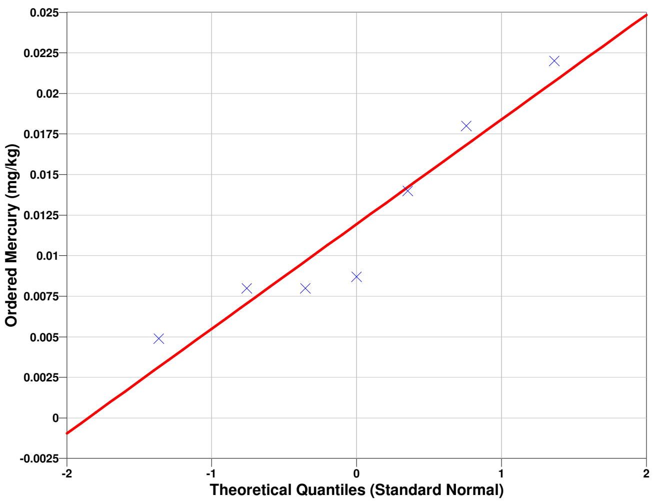
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Mercury

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST

Shapiro-Wilk Test Statistic	0.905
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.01652
95% Non-Parametric (Chebyshev) UCL	0.02222

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0.01652) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-37.364	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Nickel
The following data points were entered by the user for analysis.

Nickel (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.59	1.7	1.8	2	2.1	2.15	2.5			

SUMMARY STATISTICS for Nickel	
n	7
Min	0.59
Max	2.5

Range	1.91							
Mean	1.8343							
Median	2							
Variance	0.36806							
StdDev	0.60668							
Std Error	0.2293							
Skewness	-1.6501							
Interquartile Range	0.45							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.59	0.59	0.59	1.7	2	2.15	2.5	2.5	2.5

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Nickel	
Dixon Test Statistic	0.58115
Dixon 10% Critical Value	0.434

The calculated test statistic exceeds the critical value, so the test rejects the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.59 is an outlier at the 10% significance level.

SUSPECTED OUTLIERS for Nickel	
Min	0.59

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9605
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.59, do appear to follow a normal distribution at the 10% level of significance.

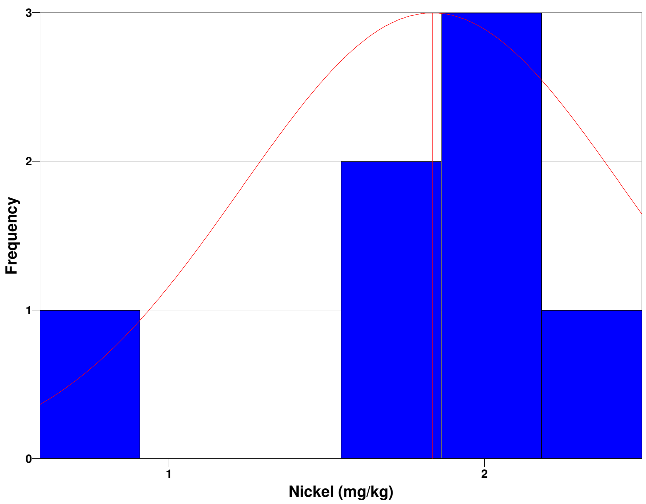
Data Plots for Nickel
Graphical displays of the data are shown below.

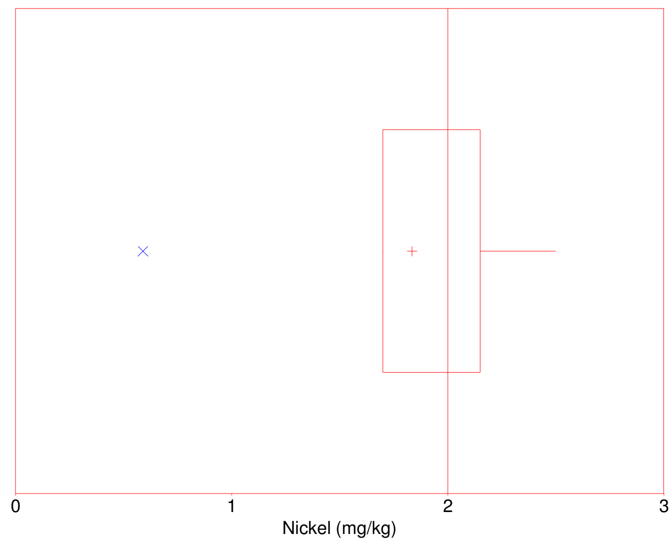
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

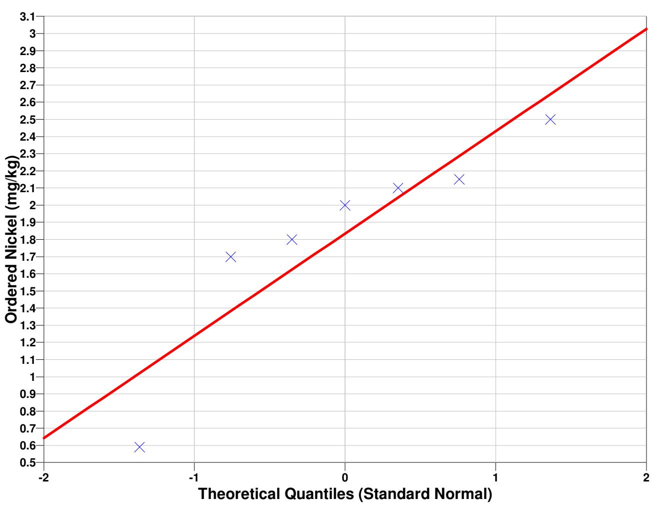
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box,

called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Nickel
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST

Shapiro-Wilk Test Statistic	0.8486
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	2.28
95% Non-Parametric (Chebyshev) UCL	2.834

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (2.28) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-122.83	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Vanadium
The following data points were entered by the user for analysis.

Vanadium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	2.5	5.5	6.1	6.2	6.3	6.5	8.4			

SUMMARY STATISTICS for Vanadium	
n	7
Min	2.5
Max	8.4

Range				5.9				
Mean				5.9286				
Median				6.2				
Variance				3.1024				
StdDev				1.7614				
Std Error				0.66573				
Skewness				-1.0685				
Interquartile Range				1				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
2.5	2.5	2.5	5.5	6.2	6.5	8.4	8.4	8.4

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Vanadium	
Dixon Test Statistic	0.50847
Dixon 10% Critical Value	0.434

The calculated test statistic exceeds the critical value, so the test rejects the null hypothesis that there are no outliers in the data, and concludes that the minimum value 2.5 is an outlier at the 10% significance level.

SUSPECTED OUTLIERS for Vanadium	
Min	2.5

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8049
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic is less than the 10% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 2.5, do not appear to follow a normal distribution at the 10% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

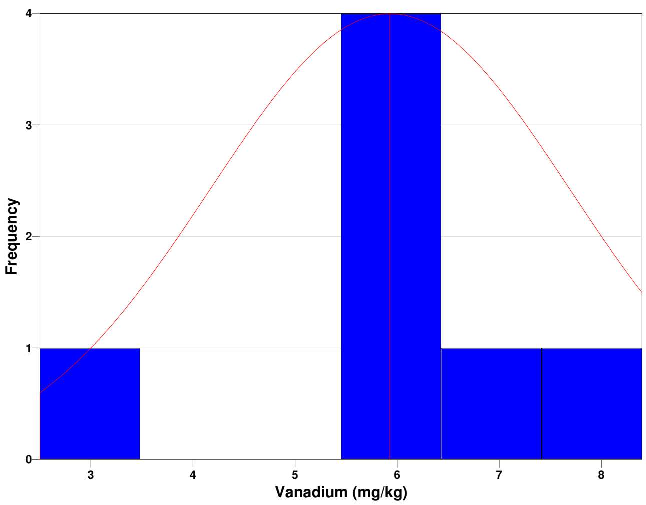
Data Plots for Vanadium
Graphical displays of the data are shown below.

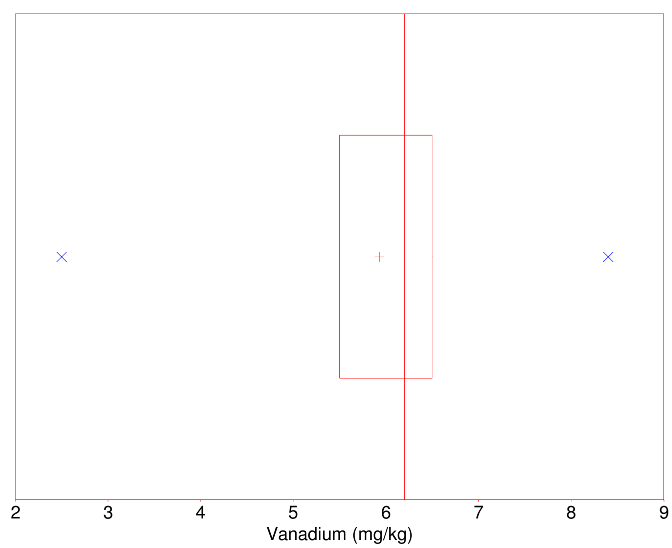
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over

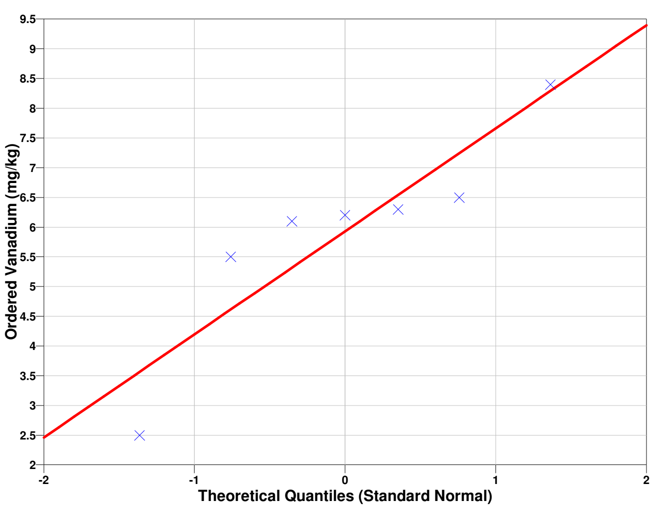
their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Vanadium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution.

The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8633
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	7.222
95% Non-Parametric (Chebyshev) UCL	8.83

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (7.222) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
5.9011	1.9432	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Data Analysis for Zinc
The following data points were entered by the user for analysis.

Zinc (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	23.9	32.8	32.9	44	66.6	279	346			

SUMMARY STATISTICS for Zinc

n	7
Min	23.9
Max	346
Range	322.1
Mean	117.89
Median	44
Variance	18230
StdDev	135.02
Std Error	51.032
Skewness	1.2754
Interquartile Range	246.2

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
23.9	23.9	23.9	32.8	44	279	346	346	346

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Zinc	
Dixon Test Statistic	0.027631
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 23.9 is not an outlier at the 10% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7492
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic is less than the 10% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 23.9, do not appear to follow a normal distribution at the 10% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

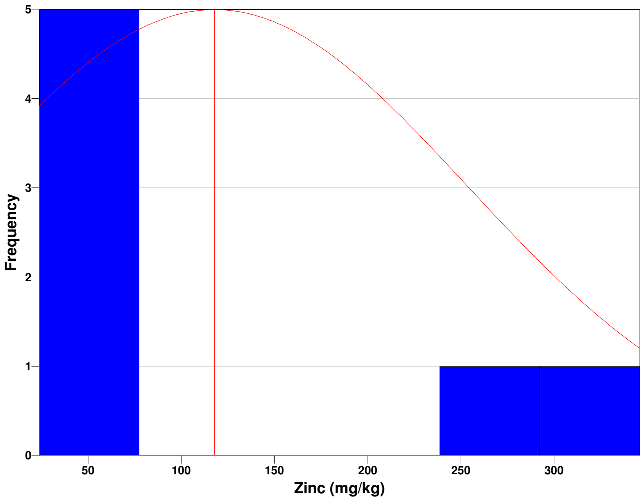
Data Plots for Zinc
Graphical displays of the data are shown below.

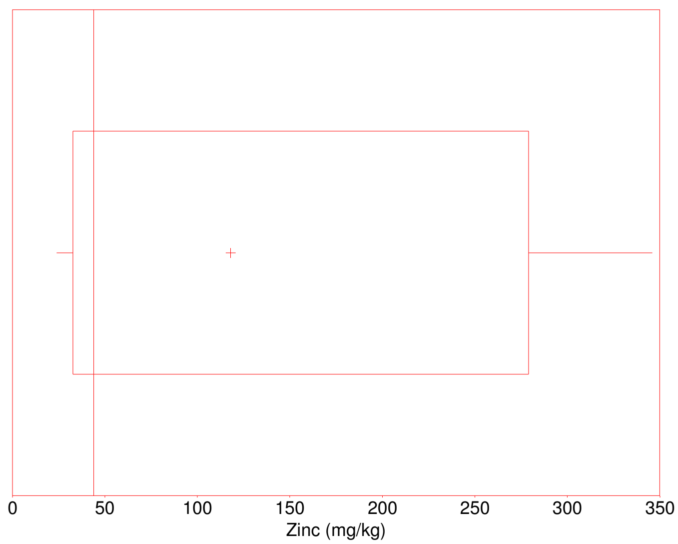
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The

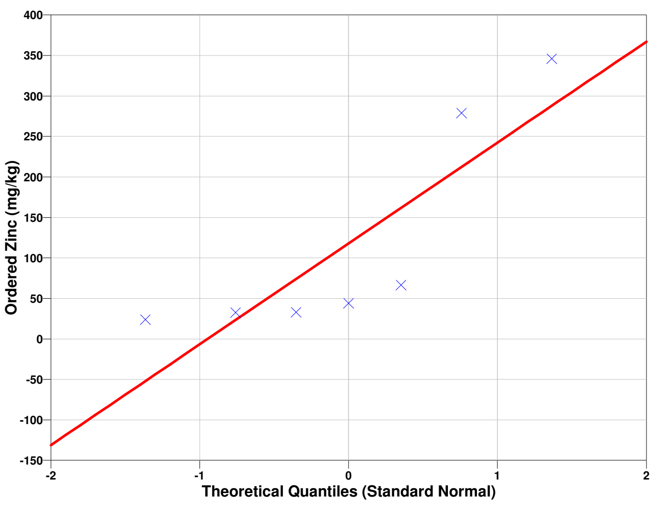
sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Zinc

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution.

The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7173
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	217
95% Non-Parametric (Chebyshev) UCL	340.3

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (340.3) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-0.041431	1.9432	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
5	6	Cannot Reject
Note: There may not be enough data to reject the null hypothesis (and conclude site is clean) with 95% confidence using the MARSSIM sign test.		

Appendix C

VSP Reports of Calculated Minimum Sample Quantity
Report 14
Area of Concern – 3
Minimum Sample Quantity Calculation for Surface Soil using Ecological Benchmarks and Delta Method 2

Random sampling locations for comparing a mean with a fixed threshold (parametric)

Summary
This report summarizes the sampling design, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design for Chromium, the driving analyte (the analyte which required the largest number of samples). A figure that shows sampling locations in the field is also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean to a fixed threshold
Type of Sampling Design	Parametric
Sample Placement (Location) in the Field	Simple random sampling
Working (Null) Hypothesis	The mean value at the site exceeds the threshold
Formula for calculating number of sampling locations	Student's t-test
Calculated total number of samples	445
Number of samples on map [a]	445
Number of selected sample areas [b]	1
Specified sampling area [c]	602117.04 m^2
Total cost of sampling [d]	$223,500.00

[a] This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[d] Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.

Primary Sampling Objective
The primary purpose of sampling at this site is to compare a mean value of a site with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the mean value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the mean value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative hypothesis, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach
A parametric random sampling approach was used to determine the number of samples and to specify sampling locations. A parametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that parametric assumptions are reasonable. These assumptions will be examined in post-sampling data analysis.

Both parametric and non-parametric approaches rely on assumptions about the population. However, non-parametric

approaches typically require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than the number of samples required by non-parametric approaches.

Locating the sample points randomly provides data that are separated by many distances, whereas systematic samples are all equidistant apart. Therefore, random sampling provides more information about the spatial structure of the potential contamination than systematic sampling does. As with systematic sampling, random sampling also provides information regarding the mean value, but there is the possibility that areas of the site will not be represented with the same frequency as if uniform grid sampling were performed.

Number of Total Samples: Calculation Equation and Inputs
The equation used to calculate the number of samples is based on a Student's t-test. For this site, the null hypothesis is rejected in favor of the alternative hypothesis if the sample mean is sufficiently smaller than the threshold. The number of samples to collect is calculated so that 1) there will be a high probability (1-β) of rejecting the null hypothesis if the alternative hypothesis is true and 2) a low probability (α) of rejecting the null hypothesis if the null hypothesis is true.

The formula used to calculate the number of samples is:

$$n = \frac{S^2}{\Delta^2}\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2 + 0.5Z_{1-\alpha}^2$$

where
n is the number of samples,
S is the estimated standard deviation of the measured values including analytical error,
Δ is the width of the gray region,
α is the acceptable probability of incorrectly concluding the site mean is less than the threshold,
β is the acceptable probability of incorrectly concluding the site mean exceeds the threshold,
$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is 1-α,
$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is 1-β.

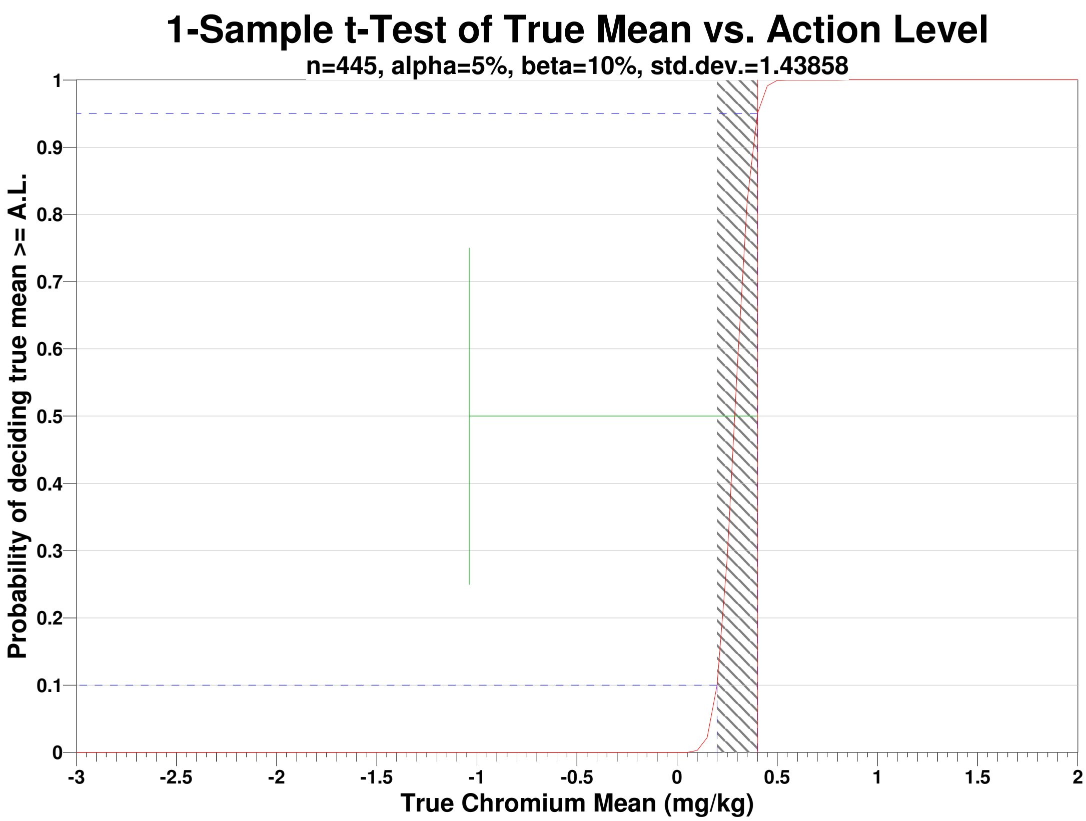
The values of these inputs that result in the calculated number of sampling locations are:

Analyte	n	Parameter					
		S	Δ	α	β	$Z_{1-\alpha}$ [a]	$Z_{1-\beta}$ [b]
New Location	2	0.1 mg/kg	10 mg/kg	0.05	0.1	1.64485	1.28155
Arsenic	2	0.594389 mg/kg	9 mg/kg	0.05	0.1	1.64485	1.28155
Barium	16	209.832 mg/kg	165 mg/kg	0.05	0.1	1.64485	1.28155
Beryllium	2	0.056614 mg/kg	5 mg/kg	0.05	0.1	1.64485	1.28155
Chromium	445	1.43858 mg/kg	0.2 mg/kg	0.05	0.1	1.64485	1.28155
Cobalt	2	0.313741 mg/kg	6.5 mg/kg	0.05	0.1	1.64485	1.28155
Copper	2	0.80593 mg/kg	30.5 mg/kg	0.05	0.1	1.64485	1.28155
Lead	2	3.39053 mg/kg	60 mg/kg	0.05	0.1	1.64485	1.28155
Manganese	2	55.6166 mg/kg	250 mg/kg	0.05	0.1	1.64485	1.28155
Mercury	2	0.00623534 mg/kg	0.05 mg/kg	0.05	0.1	1.64485	1.28155
Nickel	2	0.606681 mg/kg	15 mg/kg	0.05	0.1	1.64485	1.28155
Vanadium	28	1.76136 mg/kg	1 mg/kg	0.05	0.1	1.64485	1.28155
Zinc	45	135.018 mg/kg	60 mg/kg	0.05	0.1	1.64485	1.28155

[a] This value is automatically calculated by VSP based upon the user defined value of α.
[b] This value is automatically calculated by VSP based upon the user defined value of β.

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000) for Chromium, the driving analyte. It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true mean values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at $1-\alpha$ on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at $1-\alpha$. If any of the inputs change, the number of samples that result in the correct curve changes.



Statistical Assumptions

The assumptions associated with the formulas for computing the number of samples are:

1. the sample mean is normally distributed (this happens if the data are roughly symmetric or the sample size is more than 30; for extremely skewed data sets, additional samples may be required for the sample mean to be normally distributed),
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected randomly.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the sample locations were selected using a random process.

Sensitivity Analysis

The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that μ > action level and alpha (%), probability of mistakenly concluding that μ < action level. The following table shows the results of this analysis.

Number of Samples							
AL=120		α=5		α=10		α=15	
		s=270.036	s=135.018	s=270.036	s=135.018	s=270.036	s=135.018
LBGR=90	β=5	493216795	123304200	390294354	97573589	327649841	81912461

	β=10	390294354	97573590	299402563	74850642	244875072	61218769
	β=15	327649842	81912462	244875073	61218769	195824098	48956025
LBGR=80	β=5	123304200	30826051	97573589	24393398	81912461	20478116
	β=10	97573590	24393399	74850642	18712661	61218769	15304693
	β=15	81912462	20478117	61218769	15304693	48956025	12239007
LBGR=70	β=5	54801868	13700468	43366040	10841511	36405539	9101385
	β=10	43366041	10841512	33266953	8316739	27208342	6802086
	β=15	36405540	9101386	27208343	6802087	21758234	5439559

s = Standard Deviation
LBGR = Lower Bound of Gray Region (% of Action Level)
β = Beta (%), Probability of mistakenly concluding that μ > action level
α = Alpha (%), Probability of mistakenly concluding that μ < action level
AL = Action Level (Threshold)

Cost of Sampling
The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that are based on the number of samples collected and measured. Based on the numbers of samples determined above, the estimated total cost of sampling and analysis at this site is $223,500.00, which averages out to a per sample cost of $502.25. The following table summarizes the inputs and resulting cost estimates.

COST INFORMATION			
Cost Details	**Per Analysis**	**Per Sample**	**445 Samples**
Field collection costs		$100.00	$44,500.00
Analytical costs	$400.00	$400.00	$178,000.00
Sum of Field & Analytical costs		**$500.00**	**$222,500.00**
Fixed planning and validation costs			$1,000.00
Total cost			**$223,500.00**

Data Analysis for New Location

SUMMARY STATISTICS for New Location								
n	438							
Min	0							
Max	0							
Range	0							
Mean	0							
Median	0							
Variance	0							
StdDev	0							
Std Error	0							
Skewness	-1.#IND							
Interquartile Range	0							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**

0	0	0	0	0	0	0	0	0	0

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for New Location			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	0	-1	Yes

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Lilliefors test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Lilliefors Test Statistic	1.061e+292
Lilliefors 5% Critical Value	1.376e-313

The calculated Lilliefors test statistic exceeds the 5% Lilliefors critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

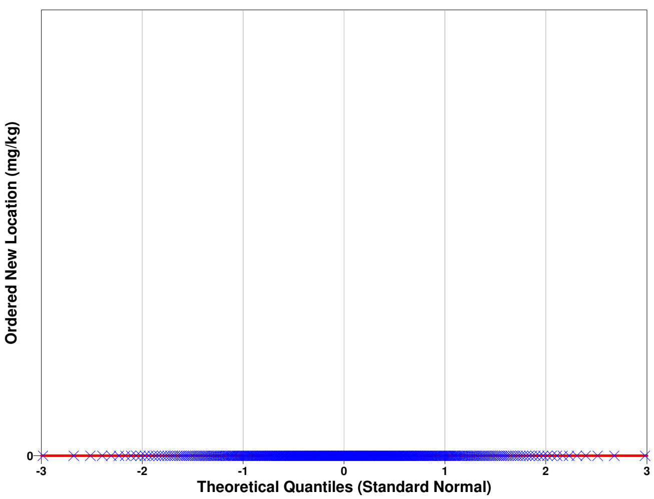
Data Plots for New Location
Graphical displays of the data are shown below.

The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a

fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.



For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for New Location
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Lilliefors test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Lilliefors Test Statistic	0
Lilliefors 5% Critical Value	0.04233

The calculated Lilliefors test statistic is less than the 5% Lilliefors critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN

95% Parametric UCL	0
95% Non-Parametric (Chebyshev) UCL	0

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=438 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=437 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.#IND	1.6483	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Data Analysis for Arsenic
The following data points were entered by the user for analysis.

Arsenic (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.72	0.96	0.965	1	1	1.1	2.5			

SUMMARY STATISTICS for Arsenic	
n	7
Min	0.72
Max	2.5
Range	1.78
Mean	1.1779
Median	1
Variance	0.3533
StdDev	0.59439
Std Error	0.22466
Skewness	2.4261
Interquartile Range	0.14
Percentiles	

1%	5%	10%	25%	50%	75%	90%	95%	99%
0.72	0.72	0.72	0.96	1	1.1	2.5	2.5	2.5

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Arsenic	
Dixon Test Statistic	0.13483
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.72 is not an outlier at the 10% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5638
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic is less than the 10% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.72, do not appear to follow a normal distribution at the 10% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

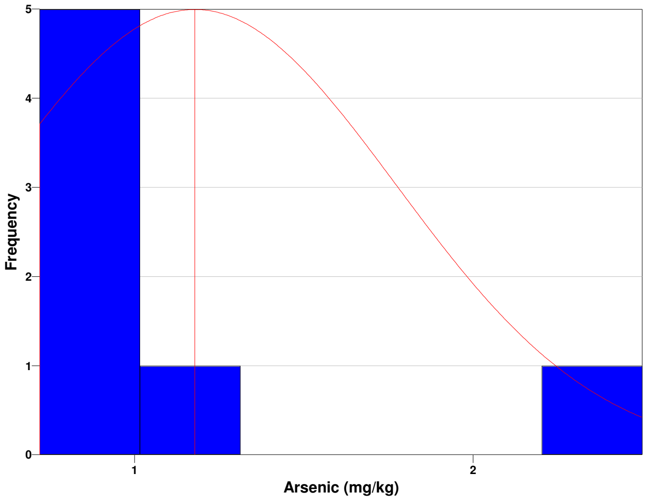
Data Plots for Arsenic
Graphical displays of the data are shown below.

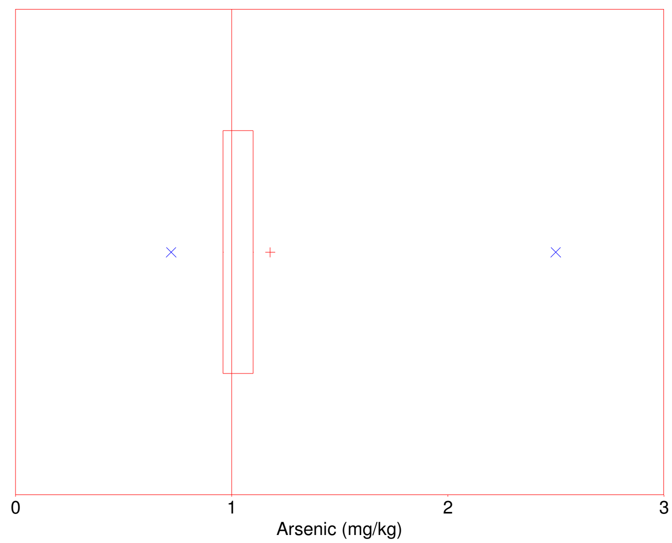
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

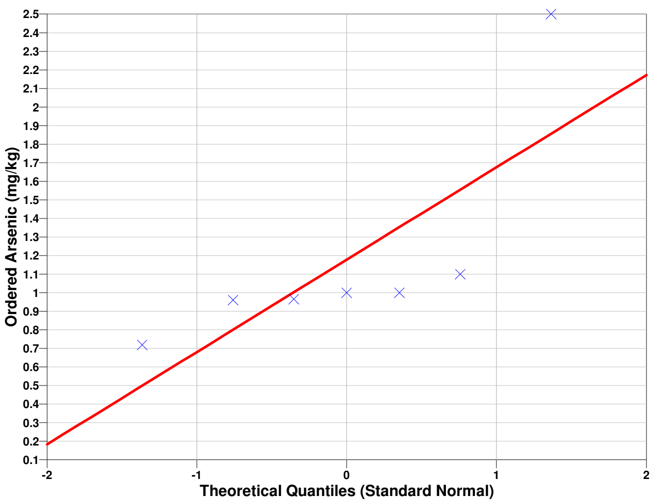
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight

line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Arsenic

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6313
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN

95% Parametric UCL	1.614
95% Non-Parametric (Chebyshev) UCL	2.157

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (2.157) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-74.879	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Data Analysis for Barium
The following data points were entered by the user for analysis.

Barium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	16.6	37.9	74.4	139	206	224	630			

SUMMARY STATISTICS for Barium	
n	7
Min	16.6
Max	630
Range	613.4
Mean	189.7
Median	139

Variance				44030				
StdDev				209.83				
Std Error				79.309				
Skewness				1.8956				
Interquartile Range				186.1				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
16.6	16.6	16.6	37.9	139	224	630	630	630

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Barium	
Dixon Test Statistic	0.034724
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 16.6 is not an outlier at the 10% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8015
Shapiro-Wilk 10% Critical Value	0.826

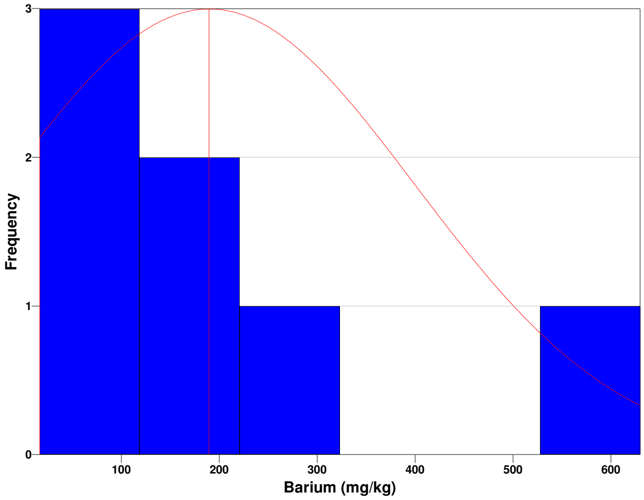
The calculated Shapiro-Wilk test statistic is less than the 10% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 16.6, do not appear to follow a normal distribution at the 10% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

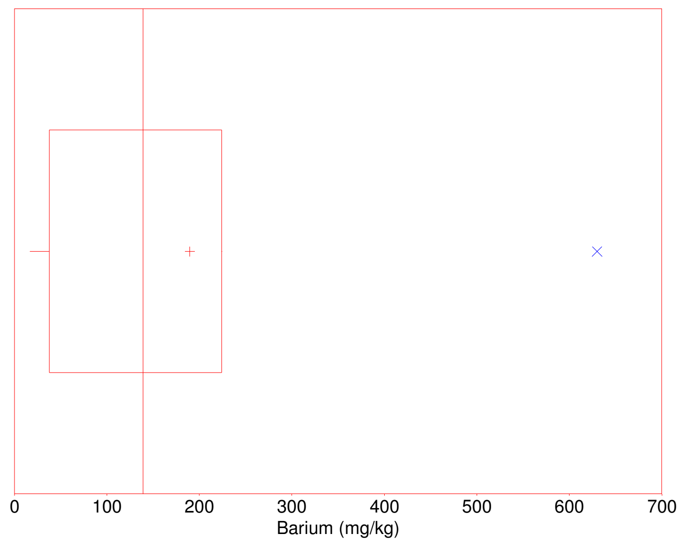
Data Plots for Barium
Graphical displays of the data are shown below.

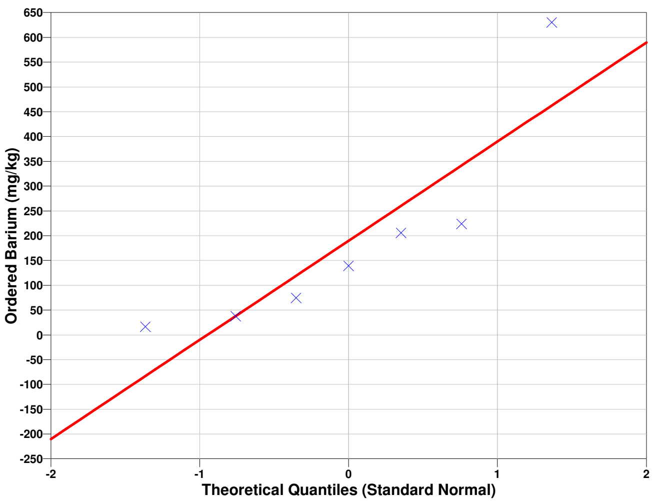
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Barium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7912
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	343.8
95% Non-Parametric (Chebyshev) UCL	535.4

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (535.4) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.769	1.9432	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
6	6	Cannot Reject
Note: There may not be enough data to reject the null hypothesis (and conclude site is clean) with 95% confidence using the MARSSIM sign test.		

Data Analysis for Beryllium
The following data points were entered by the user for analysis.

Beryllium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

0	0.074	0.15	0.17	0.18	0.21	0.23	0.24			

SUMMARY STATISTICS for Beryllium								
n				7				
Min				0.074				
Max				0.24				
Range				0.166				
Mean				0.17914				
Median				0.18				
Variance				0.0032051				
StdDev				0.056614				
Std Error				0.021398				
Skewness				-1.0307				
Interquartile Range				0.08				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.074	0.074	0.074	0.15	0.18	0.23	0.24	0.24	0.24

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Beryllium	
Dixon Test Statistic	0.45783
Dixon 10% Critical Value	0.434

The calculated test statistic exceeds the critical value, so the test rejects the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.074 is an outlier at the 10% significance level.

SUSPECTED OUTLIERS for Beryllium	
Min	0.074

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9444
Shapiro-Wilk 10% Critical Value	0.826

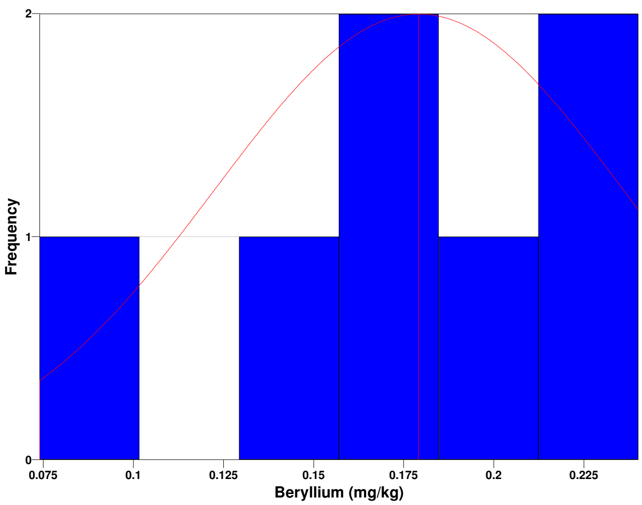
The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.074, do appear to follow a normal distribution at the 10% level of significance.

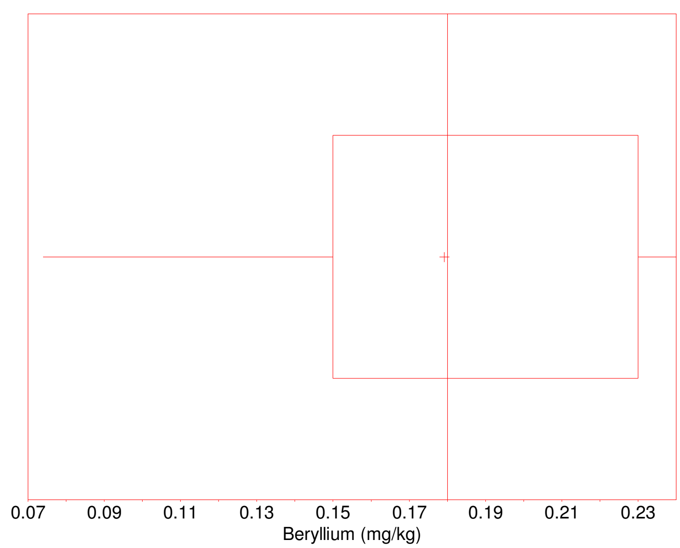
Data Plots for Beryllium
Graphical displays of the data are shown below.

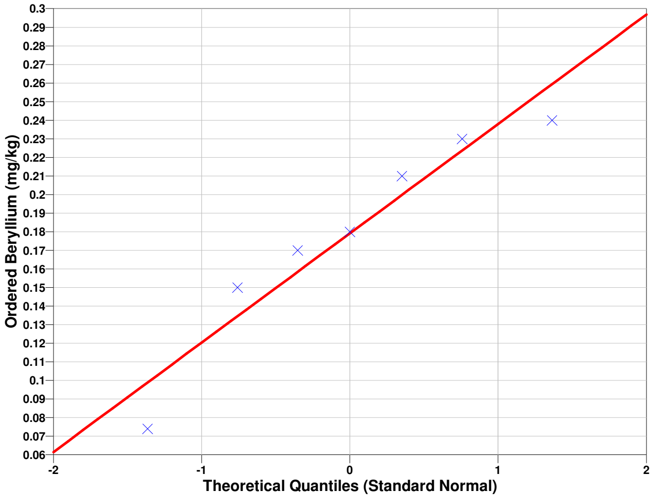
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Beryllium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9243
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.2207
95% Non-Parametric (Chebyshev) UCL	0.2724

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0.2207) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-458.96	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Chromium
The following data points were entered by the user for analysis.

Chromium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1.4	3.5	3.6	4.1	4.8	5	5.9			

SUMMARY STATISTICS for Chromium								
n	7							
Min	1.4							
Max	5.9							
Range	4.5							
Mean	4.0429							
Median	4.1							
Variance	2.0695							
StdDev	1.4386							
Std Error	0.54373							
Skewness	-0.86133							
Interquartile Range	1.5							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
1.4	1.4	1.4	3.5	4.1	5	5.9	5.9	5.9

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Chromium	
Dixon Test Statistic	0.46667
Dixon 10% Critical Value	0.434

The calculated test statistic exceeds the critical value, so the test rejects the null hypothesis that there are no outliers in the data, and concludes that the minimum value 1.4 is an outlier at the 10% significance level.

SUSPECTED OUTLIERS for Chromium	
Min	1.4

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9348
Shapiro-Wilk 10% Critical Value	0.826

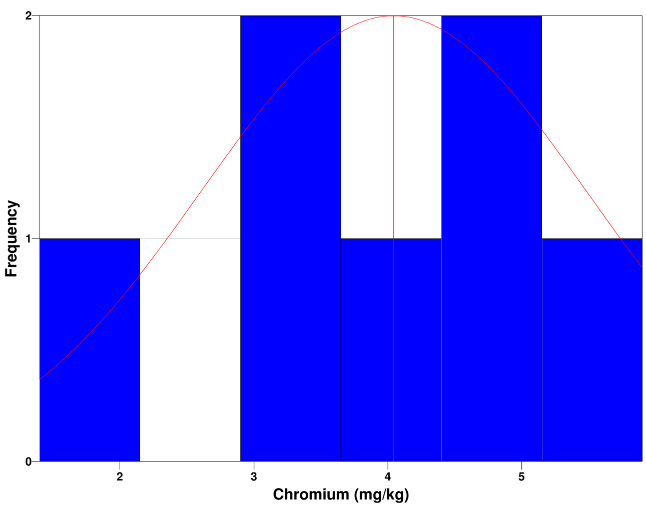
The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 1.4, do appear to follow a normal distribution at the 10% level of significance.

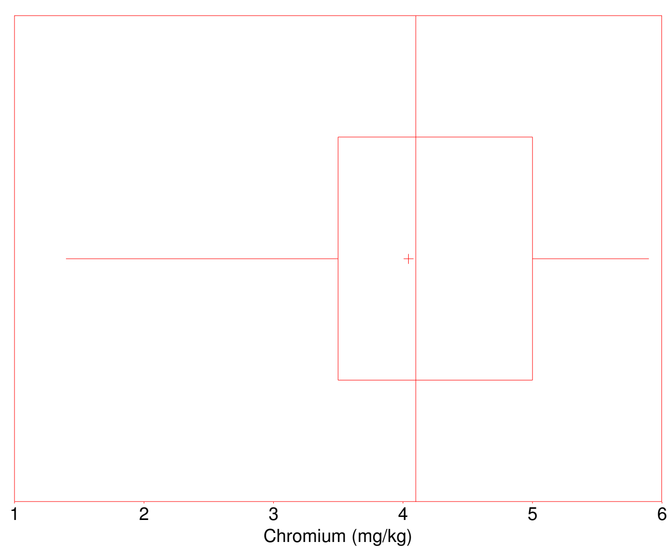
Data Plots for Chromium
Graphical displays of the data are shown below.

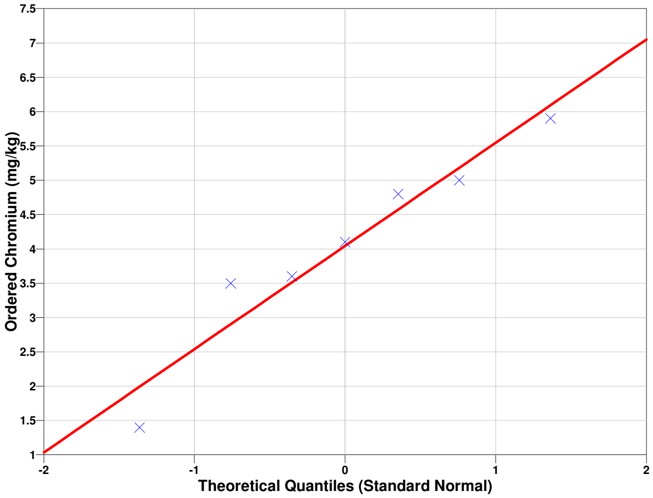
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Chromium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9462
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	5.099
95% Non-Parametric (Chebyshev) UCL	6.413

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (5.099) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
6.6997	1.9432	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Data Analysis for Cobalt
The following data points were entered by the user for analysis.

Cobalt (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.36	0.92	0.93	1	1.1	1.2	1.35			

SUMMARY STATISTICS for Cobalt	
n	7
Min	0.36
Max	1.35
Range	0.99
Mean	0.98
Median	1
Variance	0.098433
StdDev	0.31374
Std Error	0.11858
Skewness	-1.327
Interquartile Range	0.28

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.36	0.36	0.36	0.92	1	1.2	1.35	1.35	1.35

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Cobalt	
Dixon Test Statistic	0.56566
Dixon 10% Critical Value	0.434

The calculated test statistic exceeds the critical value, so the test rejects the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.36 is an outlier at the 10% significance level.

SUSPECTED OUTLIERS for Cobalt	
Min	0.36

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9171
Shapiro-Wilk 10% Critical Value	0.826

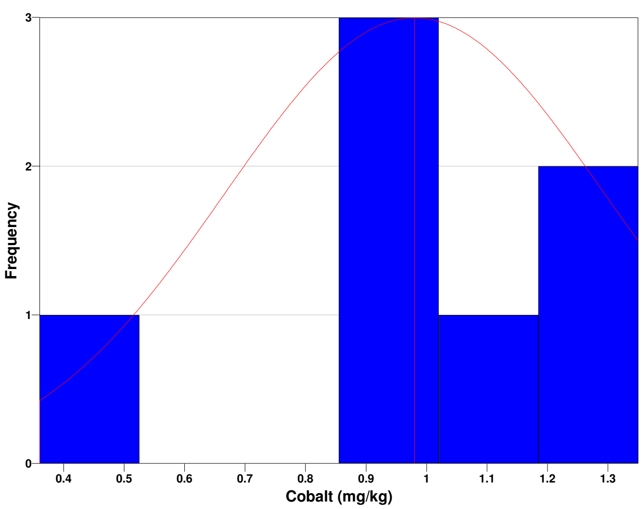
The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.36, do appear to follow a normal distribution at the 10% level of significance.

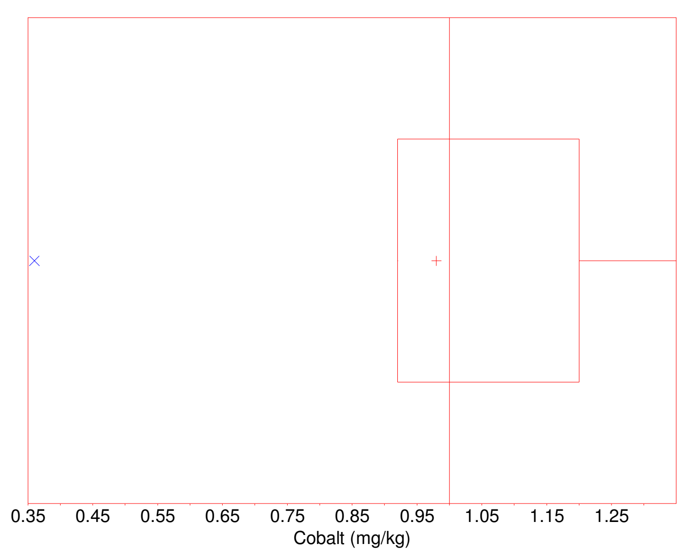
Data Plots for Cobalt
Graphical displays of the data are shown below.

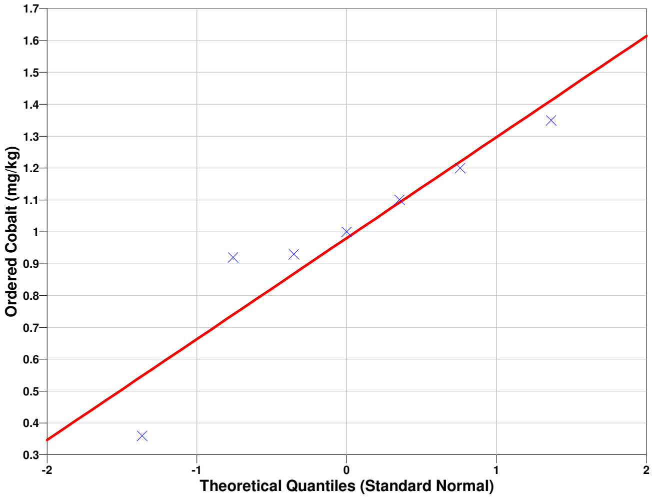
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Cobalt
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8918
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	1.21
95% Non-Parametric (Chebyshev) UCL	1.497

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (1.21) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-101.36	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Copper
The following data points were entered by the user for analysis.

Copper (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	2.5	2.6	3.2	3.9	3.9	4.2	4.6			

SUMMARY STATISTICS for Copper								
n	7							
Min	2.5							
Max	4.6							
Range	2.1							
Mean	3.5571							
Median	3.9							
Variance	0.64952							
StdDev	0.80593							
Std Error	0.30461							
Skewness	-0.27787							
Interquartile Range	1.6							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
2.5	2.5	2.5	2.6	3.9	4.2	4.6	4.6	4.6

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Copper	
Dixon Test Statistic	0.047619
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 2.5 is not an outlier at the 10% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9466
Shapiro-Wilk 10% Critical Value	0.826

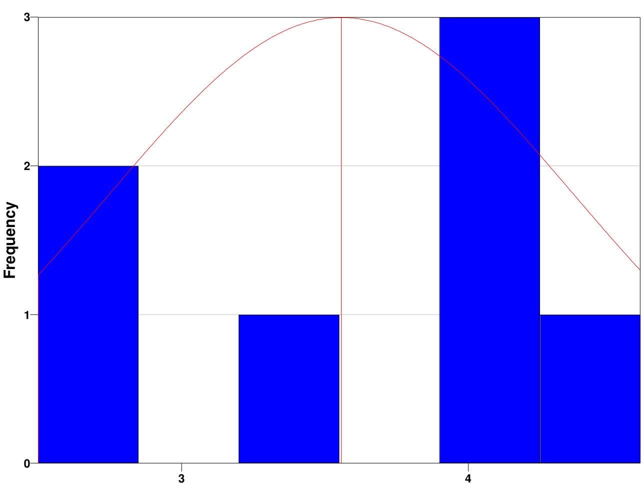
The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 2.5, do appear to follow a normal distribution at the 10% level of significance.

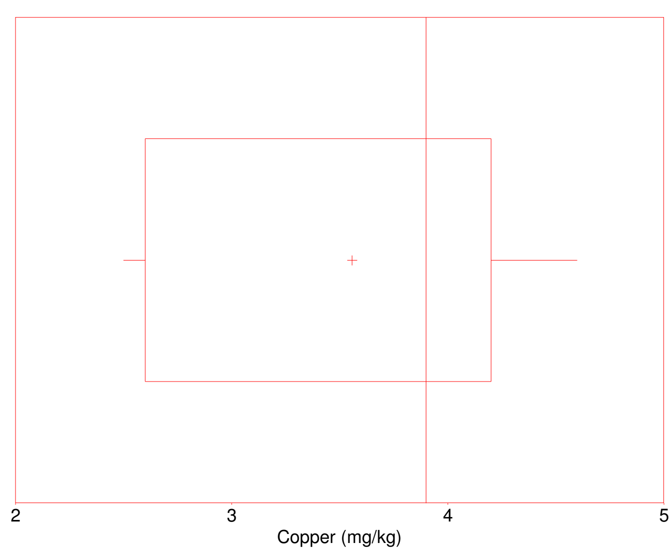
Data Plots for Copper
Graphical displays of the data are shown below.

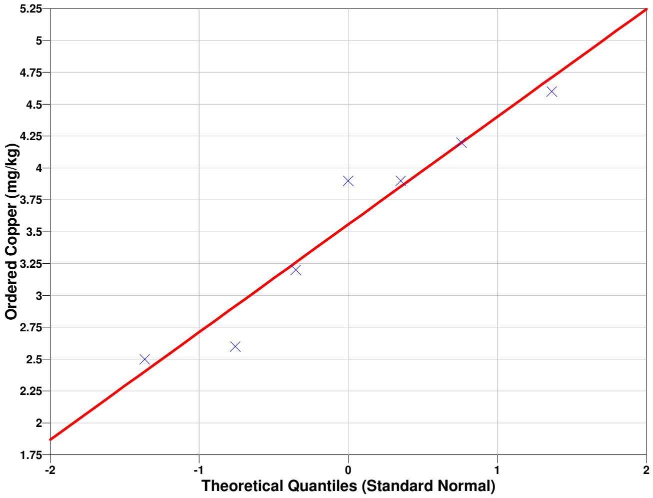
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Copper
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9185
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	4.149
95% Non-Parametric (Chebyshev) UCL	4.885

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (4.149) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-188.58	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Lead
The following data points were entered by the user for analysis.

Lead (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	3.3	4.5	4.7	5.8	7	7.9	13.5			

SUMMARY STATISTICS for Lead								
n	7							
Min	3.3							
Max	13.5							
Range	10.2							
Mean	6.6714							
Median	5.8							
Variance	11.496							
StdDev	3.3905							
Std Error	1.2815							
Skewness	1.577							
Interquartile Range	3.4							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
3.3	3.3	3.3	4.5	5.8	7.9	13.5	13.5	13.5

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Lead	
Dixon Test Statistic	0.11765
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 3.3 is not an outlier at the 10% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8277
Shapiro-Wilk 10% Critical Value	0.826

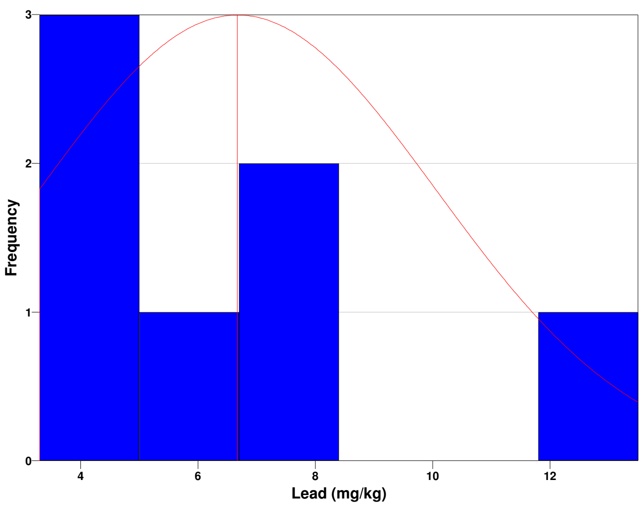
The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 3.3, do appear to follow a normal distribution at the 10% level of significance.

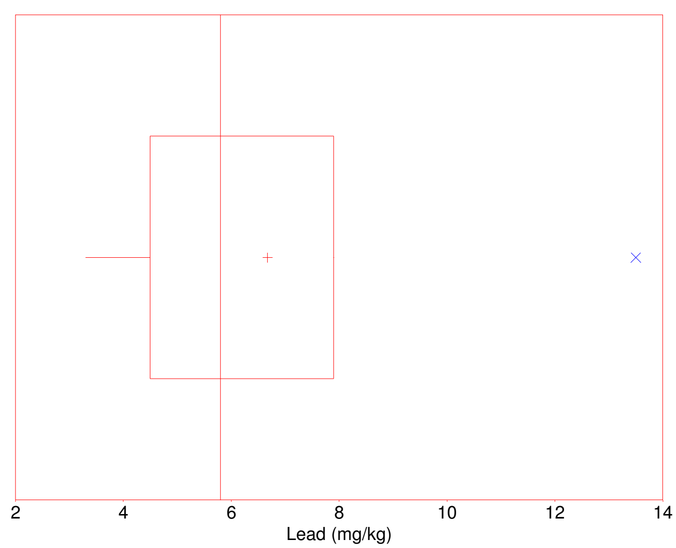
Data Plots for Lead
Graphical displays of the data are shown below.

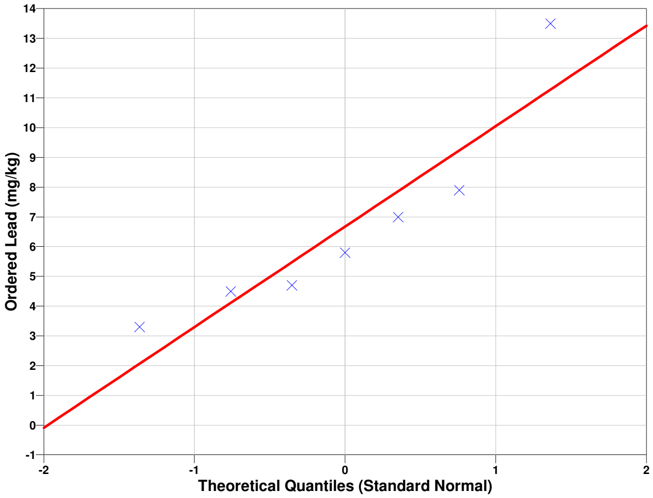
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Lead
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8619
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	9.162
95% Non-Parametric (Chebyshev) UCL	12.26

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (9.162) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-88.434	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Manganese
The following data points were entered by the user for analysis.

Manganese (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	53.3	78.7	84.5	95.9	100	113	226			

SUMMARY STATISTICS for Manganese								
n	7							
Min	53.3							
Max	226							
Range	172.7							
Mean	107.34							
Median	95.9							
Variance	3093.2							
StdDev	55.617							
Std Error	21.021							
Skewness	2.0015							
Interquartile Range	34.3							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
53.3	53.3	53.3	78.7	95.9	113	226	226	226

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Manganese	
Dixon Test Statistic	0.14708
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 53.3 is not an outlier at the 10% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7013
Shapiro-Wilk 10% Critical Value	0.826

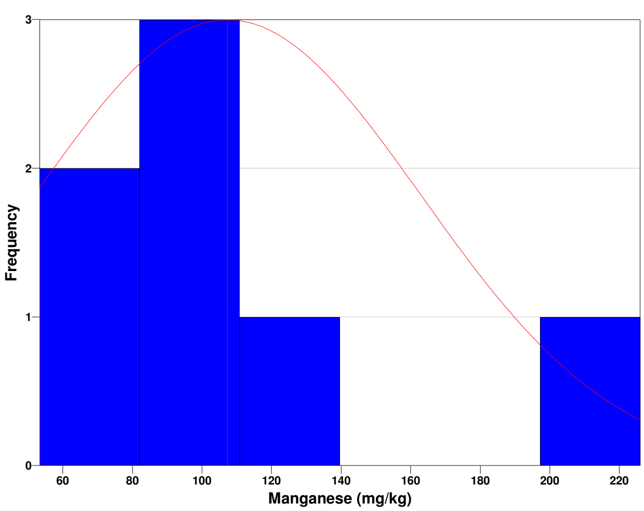
The calculated Shapiro-Wilk test statistic is less than the 10% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 53.3, do not appear to follow a normal distribution at the 10% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

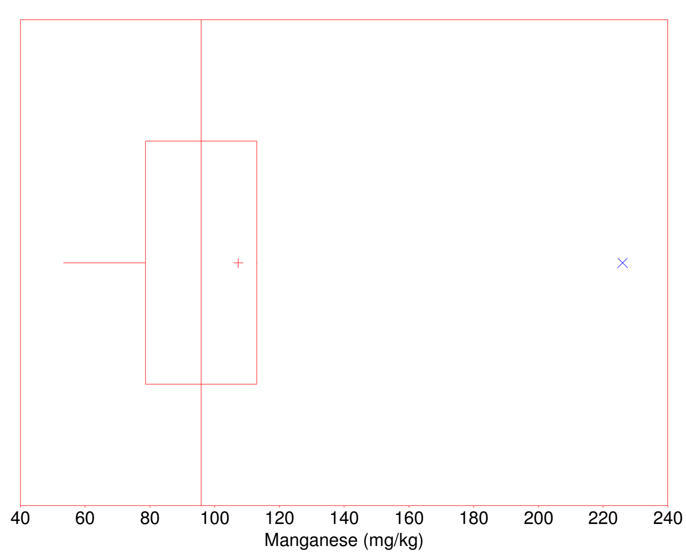
Data Plots for Manganese
Graphical displays of the data are shown below.

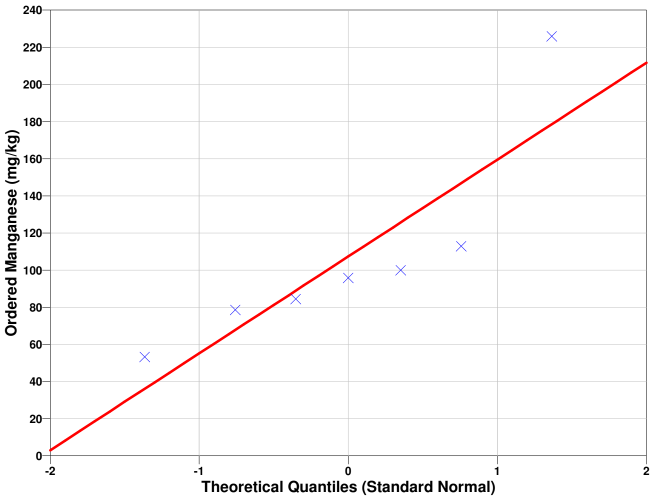
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Manganese
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7786
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	148.2
95% Non-Parametric (Chebyshev) UCL	199

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (199) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-18.679	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Data Analysis for Mercury
The following data points were entered by the user for analysis.

Mercury (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0049	0.008	0.008	0.0087	0.014	0.018	0.022			

SUMMARY STATISTICS for Mercury								
n	7							
Min	0.0049							
Max	0.022							
Range	0.0171							
Mean	0.011943							
Median	0.0087							
Variance	3.888e-005							
StdDev	0.0062353							
Std Error	0.0023567							
Skewness	0.7143							
Interquartile Range	0.01							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0049	0.0049	0.0049	0.008	0.0087	0.018	0.022	0.022	0.022

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible

explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Mercury	
Dixon Test Statistic	0.18129
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.0049 is not an outlier at the 10% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8587
Shapiro-Wilk 10% Critical Value	0.826

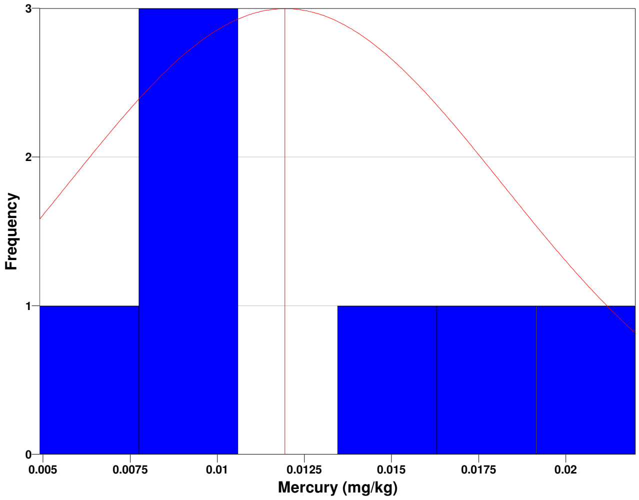
The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.0049, do appear to follow a normal distribution at the 10% level of significance.

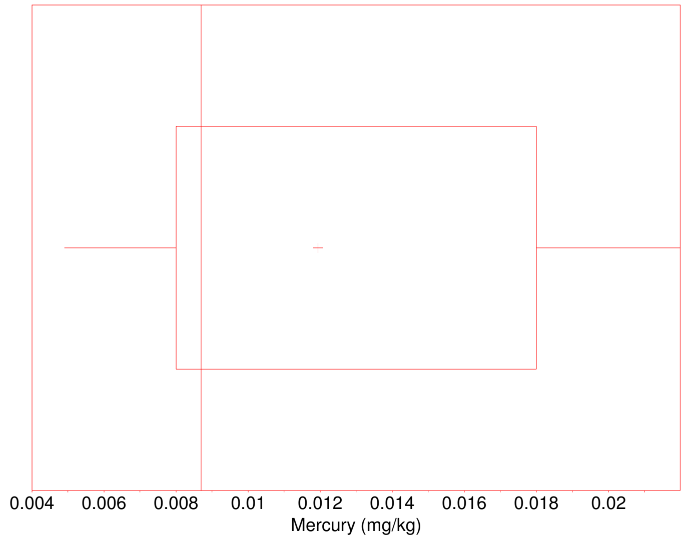
Data Plots for Mercury
Graphical displays of the data are shown below.

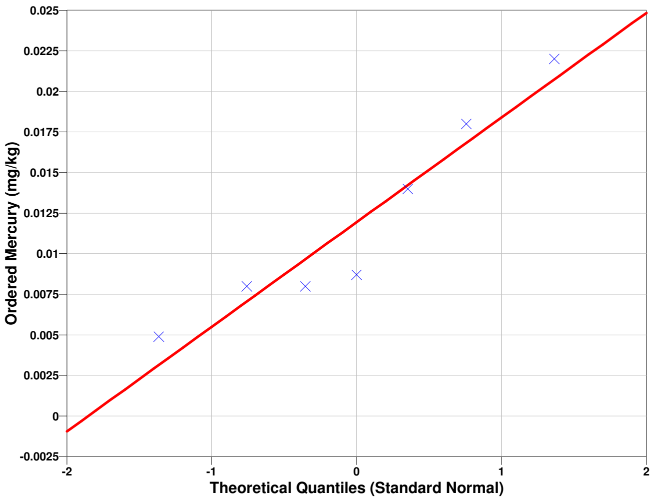
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Mercury

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.905
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.01652

95% Non-Parametric (Chebyshev) UCL	0.02222

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0.01652) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-37.364	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Nickel
The following data points were entered by the user for analysis.

Nickel (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.59	1.7	1.8	2	2.1	2.15	2.5			

SUMMARY STATISTICS for Nickel	
n	7
Min	0.59
Max	2.5
Range	1.91
Mean	1.8343
Median	2
Variance	0.36806
StdDev	0.60668
Std Error	0.2293
Skewness	-1.6501
Interquartile Range	0.45

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**

0.59	0.59	0.59	1.7	2	2.15	2.5	2.5	2.5

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Nickel	
Dixon Test Statistic	0.58115
Dixon 10% Critical Value	0.434

The calculated test statistic exceeds the critical value, so the test rejects the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.59 is an outlier at the 10% significance level.

SUSPECTED OUTLIERS for Nickel	
Min	0.59

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9605
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.59, do appear to follow a normal distribution at the 10% level of significance.

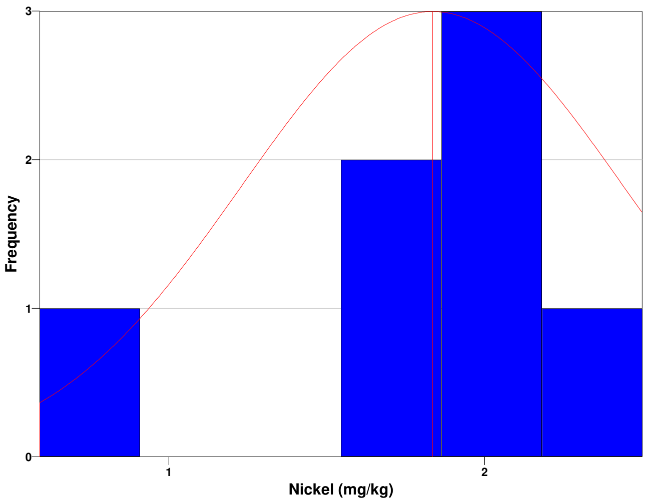
Data Plots for Nickel
Graphical displays of the data are shown below.

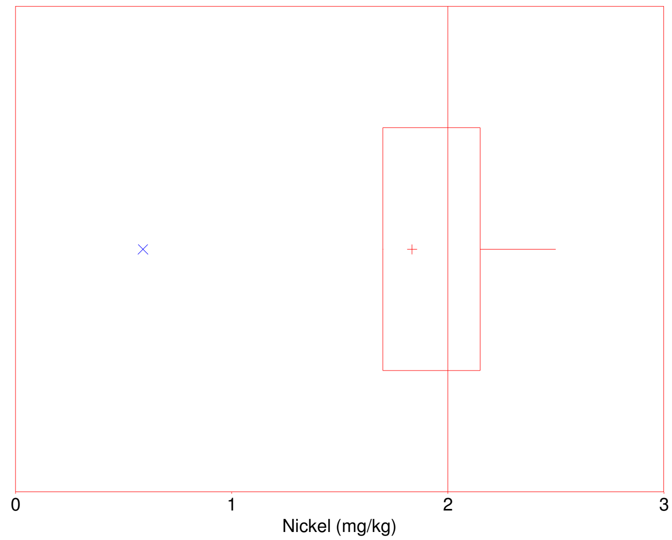
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

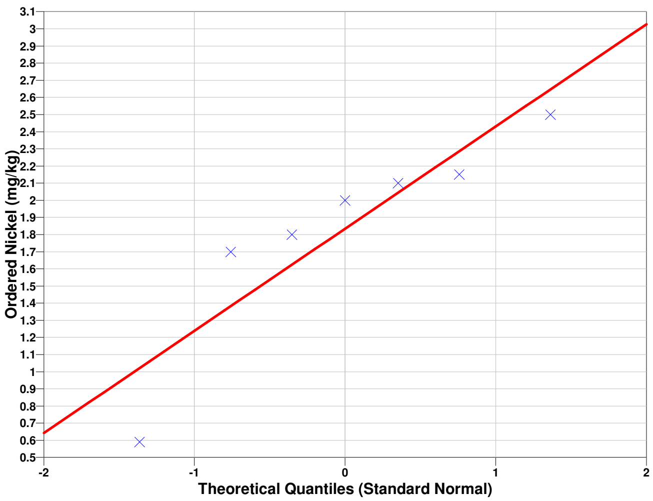
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate

substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Nickel
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8486
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN

95% Parametric UCL	2.28
95% Non-Parametric (Chebyshev) UCL	2.834

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (2.28) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-122.83	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Vanadium
The following data points were entered by the user for analysis.

Vanadium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	2.5	5.5	6.1	6.2	6.3	6.5	8.4			

SUMMARY STATISTICS for Vanadium	
n	7
Min	2.5
Max	8.4
Range	5.9
Mean	5.9286
Median	6.2
Variance	3.1024
StdDev	1.7614
Std Error	0.66573
Skewness	-1.0685
Interquartile Range	1
Percentiles	

1%	5%	10%	25%	50%	75%	90%	95%	99%
2.5	2.5	2.5	5.5	6.2	6.5	8.4	8.4	8.4

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Vanadium	
Dixon Test Statistic	0.50847
Dixon 10% Critical Value	0.434

The calculated test statistic exceeds the critical value, so the test rejects the null hypothesis that there are no outliers in the data, and concludes that the minimum value 2.5 is an outlier at the 10% significance level.

SUSPECTED OUTLIERS for Vanadium	
Min	2.5

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8049
Shapiro-Wilk 10% Critical Value	0.826

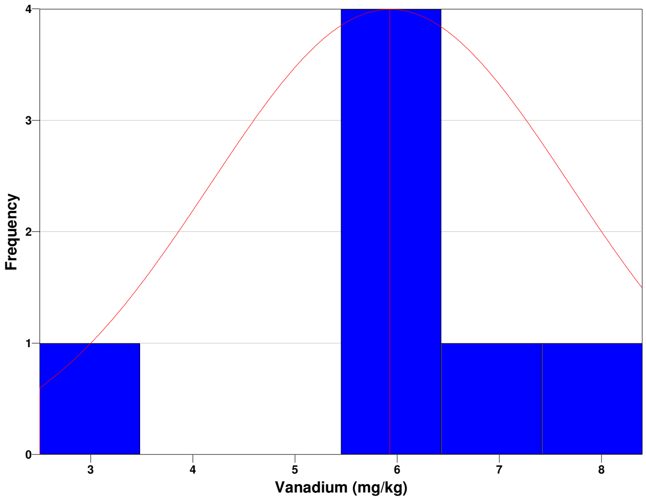
The calculated Shapiro-Wilk test statistic is less than the 10% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 2.5, do not appear to follow a normal distribution at the 10% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

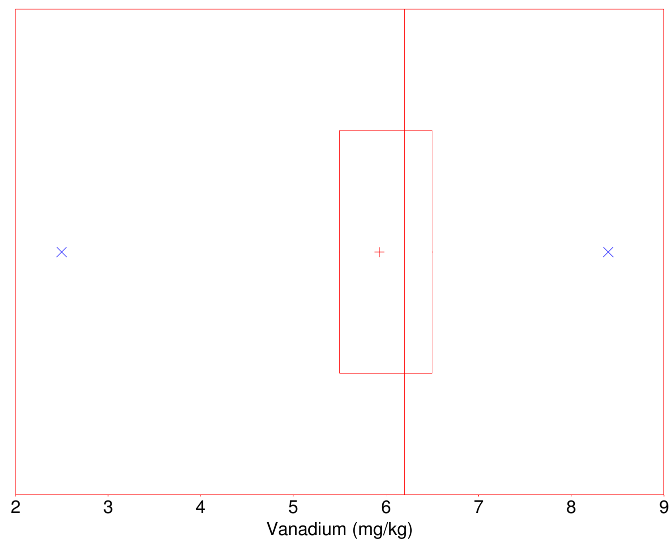
Data Plots for Vanadium
Graphical displays of the data are shown below.

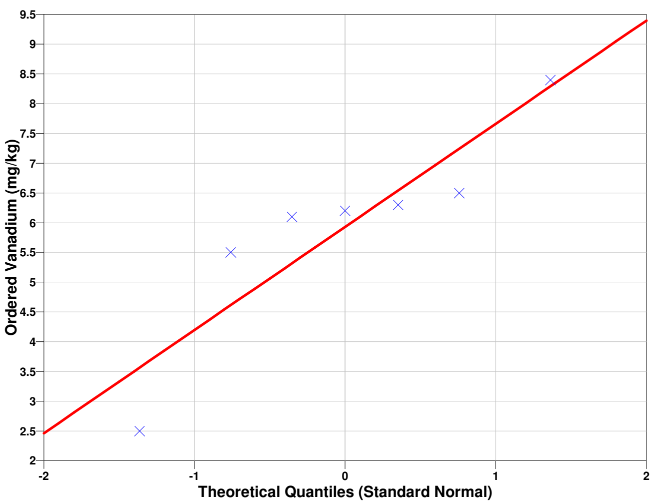
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Vanadium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8633
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that

assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	7.222
95% Non-Parametric (Chebyshev) UCL	8.83

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (7.222) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
5.9011	1.9432	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Data Analysis for Zinc
The following data points were entered by the user for analysis.

Zinc (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	23.9	32.8	32.9	44	66.6	279	346			

SUMMARY STATISTICS for Zinc	
n	7
Min	23.9
Max	346
Range	322.1
Mean	117.89
Median	44
Variance	18230
StdDev	135.02
Std Error	51.032
Skewness	1.2754

Interquartile Range				246.2				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
23.9	23.9	23.9	32.8	44	279	346	346	346

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Zinc	
Dixon Test Statistic	0.027631
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 23.9 is not an outlier at the 10% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7492
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic is less than the 10% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 23.9, do not appear to follow a normal distribution at the 10% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

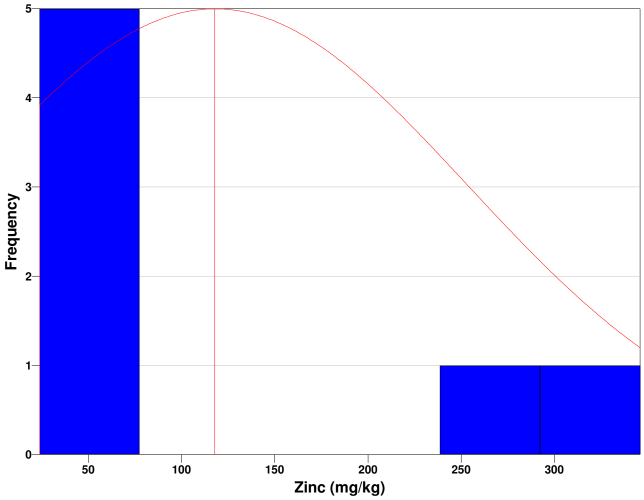
Data Plots for Zinc
Graphical displays of the data are shown below.

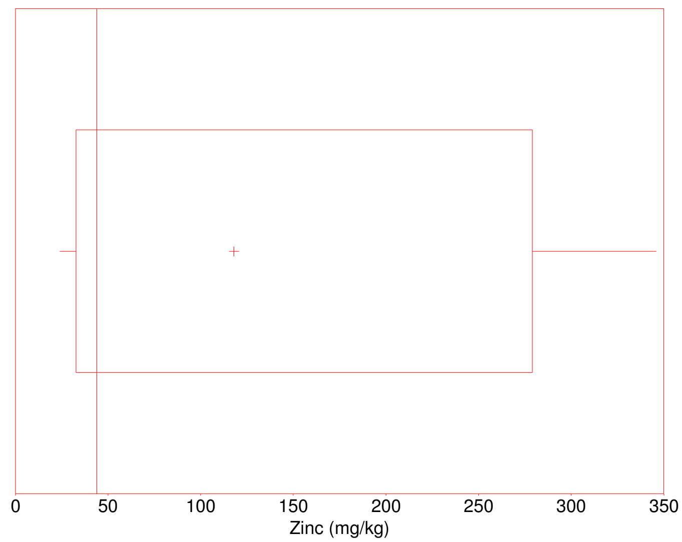
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

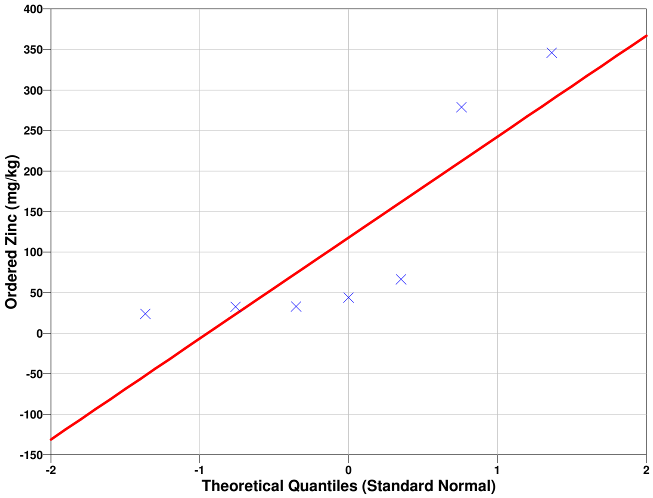
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the

Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Zinc
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7173
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	217
95% Non-Parametric (Chebyshev) UCL	340.3

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (340.3) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-0.041431	1.9432	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
5	6	Cannot Reject
Note: There may not be enough data to reject the null hypothesis (and conclude site is clean) with 95% confidence using the MARSSIM sign test.		

This report was automatically produced* by Visual Sample Plan (VSP) software version 5.3.1.
Software and documentation available at http://dqo.pnl.gov/vsp

* - The report contents may have been modified or reformatted by end-user of software.

Appendix C

VSP Reports of Calculated Minimum Sample Quantity
Report 15
Area of Concern – 3
Minimum Sample Quantity Calculation for Subsurface Soil using Human Health Benchmarks and Delta Method 1

Random sampling locations for comparing a mean with a fixed threshold (parametric)

Summary

This report summarizes the sampling design, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design for Arsenic, the driving analyte (the analyte which required the largest number of samples). A figure that shows sampling locations in the field and a table that lists sampling location coordinates are also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean to a fixed threshold
Type of Sampling Design	Parametric
Sample Placement (Location) in the Field	Simple random sampling
Working (Null) Hypothesis	The mean value at the site exceeds the threshold
Formula for calculating number of sampling locations	Student's t-test
Calculated total number of samples	8
Number of samples on map [a]	8
Number of selected sample areas [b]	1
Specified sampling area [c]	602117.04 m^2
Total cost of sampling [d]	$5,000.00

[a] This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[d] Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.

Area: Area 1					
X Coord	**Y Coord**	**Label**	**Value**	**Type**	**Historical**

680077.3540	3083115.5330	J-50S		Manual	T
680141.8730	3083080.8800	J-52S		Manual	T
680170.5600	3083064.6740	J-53S		Manual	T
679924.8150	3082872.3490	J-47S		Manual	T
679994.9690	3082983.5100	J-48S		Manual	T
680057.6580	3083072.0750	J-49S		Manual	T
679827.1150	3082729.7460	J-51S		Manual	T
680081.1503	3083422.3781		0	Adaptive-Fill	

Primary Sampling Objective
The primary purpose of sampling at this site is to compare a mean value of a site with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the mean value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the mean value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative hypothesis, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach
A parametric random sampling approach was used to determine the number of samples and to specify sampling locations. A parametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that parametric assumptions are reasonable. These assumptions will be examined in post-sampling data analysis.

Both parametric and non-parametric approaches rely on assumptions about the population. However, non-parametric approaches typically require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than the number of samples required by non-parametric approaches.

Locating the sample points randomly provides data that are separated by many distances, whereas systematic samples are all equidistant apart. Therefore, random sampling provides more information about the spatial structure of the potential contamination than systematic sampling does. As with systematic sampling, random sampling also provides information regarding the mean value, but there is the possibility that areas of the site will not be represented with the same frequency as if uniform grid sampling were performed.

Number of Total Samples: Calculation Equation and Inputs
The equation used to calculate the number of samples is based on a Student's t-test. For this site, the null hypothesis is rejected in favor of the alternative hypothesis if the sample mean is sufficiently smaller than the threshold. The number of samples to collect is calculated so that 1) there will be a high probability ($1-\beta$) of rejecting the null hypothesis if the alternative hypothesis is true and 2) a low probability (α) of rejecting the null hypothesis if the null hypothesis is true.

The formula used to calculate the number of samples is:

$$n = \frac{S^2}{\Delta^2}\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2 + 0.5Z_{1-\alpha}^2$$

where
n is the number of samples,
S is the estimated standard deviation of the measured values including analytical error,
Δ is the width of the gray region,
α is the acceptable probability of incorrectly concluding the site mean is less than the threshold,
β is the acceptable probability of incorrectly concluding the site mean exceeds the threshold,
$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is $1-\alpha$,
$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is $1-\beta$.

The values of these inputs that result in the calculated number of sampling locations are:

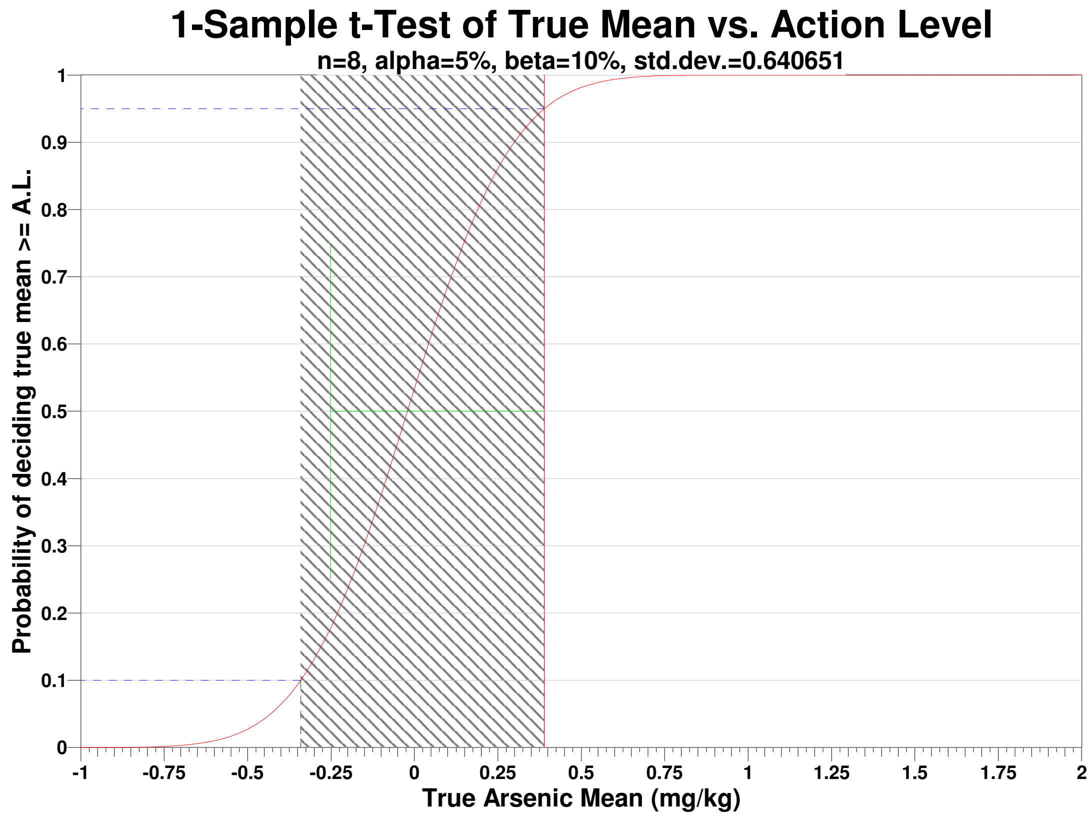
Analyte	**n**	**Parameter**

	S	Δ	α	β	$Z_{1-\alpha}$ [a]	$Z_{1-\beta}$ [b]	
New Location	2	0.1 mg/kg	10 mg/kg	0.05	0.1	1.64485	1.28155
Acetone	2	0.0244015 mg/kg	5417.38 mg/kg	0.05	0.1	1.64485	1.28155
Aluminum	2	776.733 mg/kg	2892.59 mg/kg	0.05	0.1	1.64485	1.28155
Arsenic	8	0.640651 mg/kg	0.730376 mg/kg	0.05	0.1	1.64485	1.28155
Barium	2	68.7947 mg/kg	7785.32 mg/kg	0.05	0.1	1.64485	1.28155
Beryllium	2	0.0385894 mg/kg	37.4033 mg/kg	0.05	0.1	1.64485	1.28155
Chromium	2	0.649175 mg/kg	207.39 mg/kg	0.05	0.1	1.64485	1.28155
Cobalt	2	0.200321 mg/kg	902.049 mg/kg	0.05	0.1	1.64485	1.28155
Copper	2	1.19563 mg/kg	545.153 mg/kg	0.05	0.1	1.64485	1.28155
Lead	2	0.638823 mg/kg	397.014 mg/kg	0.05	0.1	1.64485	1.28155
Manganese	2	36.2173 mg/kg	3166.54 mg/kg	0.05	0.1	1.64485	1.28155
Mercury	2	0.0139463 mg/kg	2.07356 mg/kg	0.05	0.1	1.64485	1.28155
Nickel	2	0.402965 mg/kg	830.476 mg/kg	0.05	0.1	1.64485	1.28155
Toluene	2	0.000511068 mg/kg	521.169 mg/kg	0.05	0.1	1.64485	1.28155
Vanadium	2	1.20929 mg/kg	285.686 mg/kg	0.05	0.1	1.64485	1.28155
Zinc	2	9.15387 mg/kg	9904.87 mg/kg	0.05	0.1	1.64485	1.28155

[a] This value is automatically calculated by VSP based upon the user defined value of α.
[b] This value is automatically calculated by VSP based upon the user defined value of β.

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000) for Arsenic, the driving analyte. It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true mean values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at 1-α on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at 1-α. If any of the inputs change, the number of samples that result in the correct curve changes.



Statistical Assumptions
The assumptions associated with the formulas for computing the number of samples are:

1. the sample mean is normally distributed (this happens if the data are roughly symmetric or the sample size is more than 30; for extremely skewed data sets, additional samples may be required for the sample mean to be normally distributed),
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected randomly.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the sample locations were selected using a random process.

Sensitivity Analysis
The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that μ > action level and alpha (%), probability of mistakenly concluding that μ < action level. The following table shows the results of this analysis.

Number of Samples							
AL=9921.47		α=5		α=10		α=15	
		s=18.3077	s=9.15387	s=18.3077	s=9.15387	s=18.3077	s=9.15387
LBGR=90	β=5	2389422	597357	1890807	472703	1587322	396831
	β=10	1890808	472703	1450476	362620	1186314	296579
	β=15	1587323	396832	1186314	296580	948683	237172
LBGR=80	β=5	597357	149341	472703	118177	396831	99209
	β=10	472703	118177	362620	90656	296579	74146
	β=15	396832	99209	296580	74146	237172	59294
LBGR=70	β=5	265493	66375	210091	52524	176370	44093

	β=10	210091	52524	161165	40292	131814	32954
	β=15	176371	44094	131814	32954	105410	26353

s = Standard Deviation
LBGR = Lower Bound of Gray Region (% of Action Level)
β = Beta (%), Probability of mistakenly concluding that μ > action level
α = Alpha (%), Probability of mistakenly concluding that μ < action level
AL = Action Level (Threshold)

Cost of Sampling
The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that are based on the number of samples collected and measured. Based on the numbers of samples determined above, the estimated total cost of sampling and analysis at this site is $5,000.00, which averages out to a per sample cost of $625.00. The following table summarizes the inputs and resulting cost estimates.

COST INFORMATION			
Cost Details	**Per Analysis**	**Per Sample**	**8 Samples**
Field collection costs		$100.00	$800.00
Analytical costs	$400.00	$400.00	$3,200.00
Sum of Field & Analytical costs		**$500.00**	**$4,000.00**
Fixed planning and validation costs			$1,000.00
Total cost			**$5,000.00**

Data Analysis for Acetone
The following data points were entered by the user for analysis.

Acetone (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0094	0.0144	0.0164	0.0165	0.0305	0.0331	0.0804			

SUMMARY STATISTICS for Acetone								
n	7							
Min	0.0094							
Max	0.0804							
Range	0.071							
Mean	0.028671							
Median	0.0165							
Variance	0.00059543							
StdDev	0.024401							
Std Error	0.0092229							
Skewness	2.0041							
Interquartile Range	0.0187							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0094	0.0094	0.0094	0.0144	0.0165	0.0331	0.0804	0.0804	0.0804

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Acetone	
Dixon Test Statistic	0.070423
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.0094 is not an outlier at the 10% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7448
Shapiro-Wilk 10% Critical Value	0.826

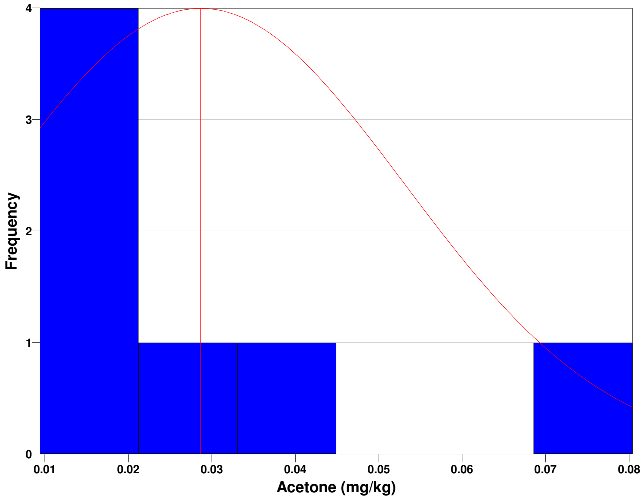
The calculated Shapiro-Wilk test statistic is less than the 10% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.0094, do not appear to follow a normal distribution at the 10% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

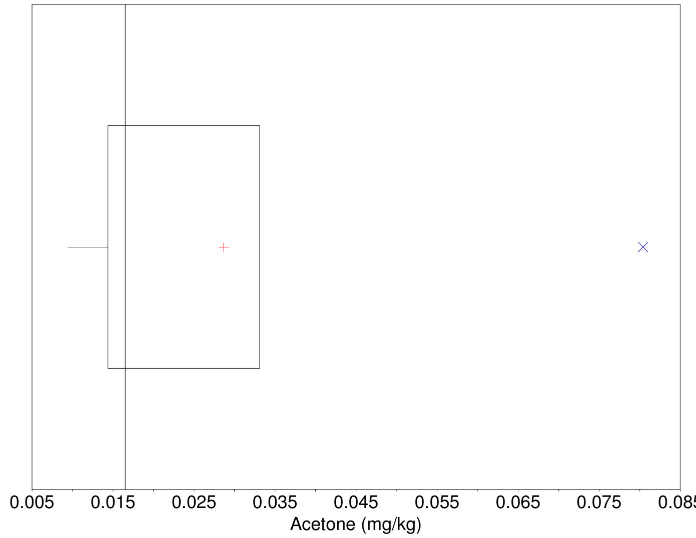
Data Plots for Acetone
Graphical displays of the data are shown below.

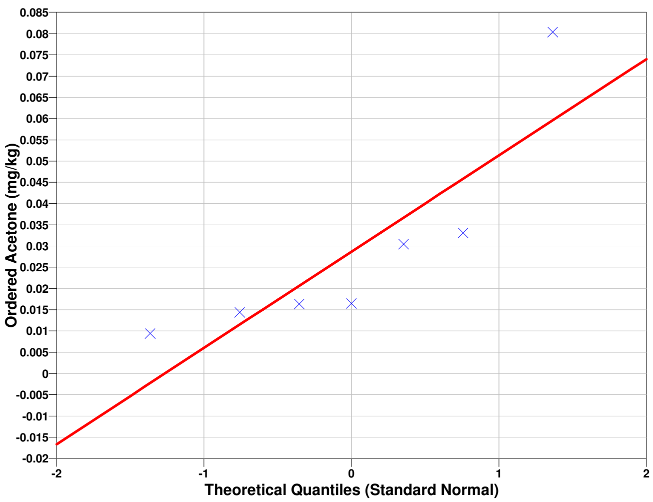
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Acetone
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7539
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.04659

95% Non-Parametric (Chebyshev) UCL	0.06887

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.06887) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-5.8738e+005	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Data Analysis for Aluminum
The following data points were entered by the user for analysis.

Aluminum (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	2400	3070	3290	3570	4210	4260	4600			

SUMMARY STATISTICS for Aluminum	
n	7
Min	2400
Max	4600
Range	2200
Mean	3628.6
Median	3570
Variance	6.0331e+005

StdDev				776.73				
Std Error				293.58				
Skewness				-0.34987				
Interquartile Range				1190				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
2400	2400	2400	3070	3570	4260	4600	4600	4600

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Aluminum	
Dixon Test Statistic	0.30455
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 2400 is not an outlier at the 10% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9262
Shapiro-Wilk 10% Critical Value	0.826

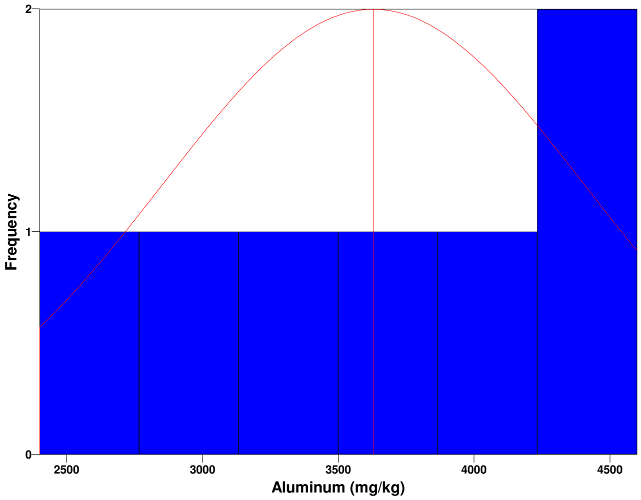
The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 2400, do appear to follow a normal distribution at the 10% level of significance.

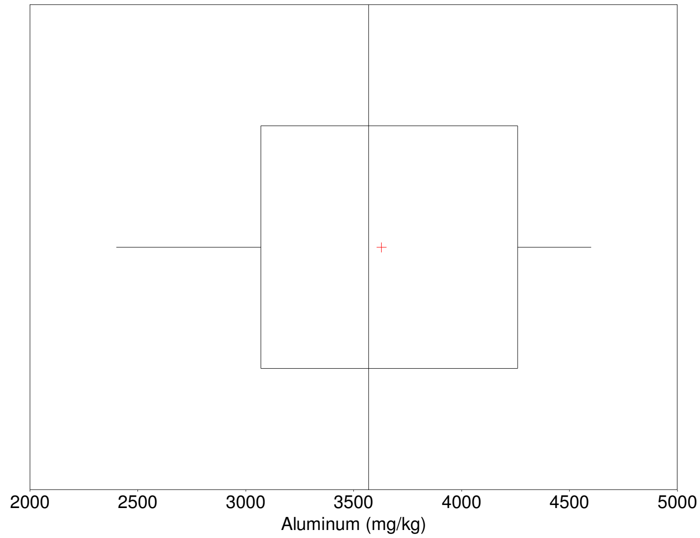
Data Plots for Aluminum
Graphical displays of the data are shown below.

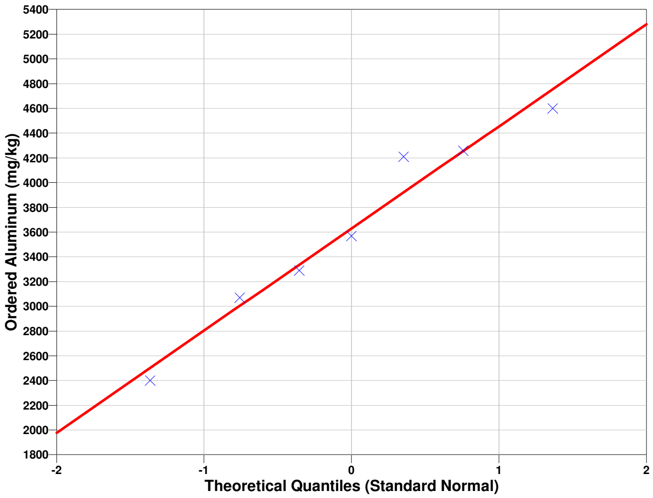
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Aluminum

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9566
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that

assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	4199
95% Non-Parametric (Chebyshev) UCL	4908

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (4199) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-9.8529	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Arsenic
The following data points were entered by the user for analysis.

Arsenic (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.52	0.63	0.69	1.1	1.2	1.3	2.4			

SUMMARY STATISTICS for Arsenic	
n	7
Min	0.52
Max	2.4
Range	1.88
Mean	1.12
Median	1.1
Variance	0.41043
StdDev	0.64065
Std Error	0.24214
Skewness	1.5

Interquartile Range				0.67				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.52	0.52	0.52	0.63	1.1	1.3	2.4	2.4	2.4

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Arsenic	
Dixon Test Statistic	0.058511
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.52 is not an outlier at the 10% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8507
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.52, do appear to follow a normal distribution at the 10% level of significance.

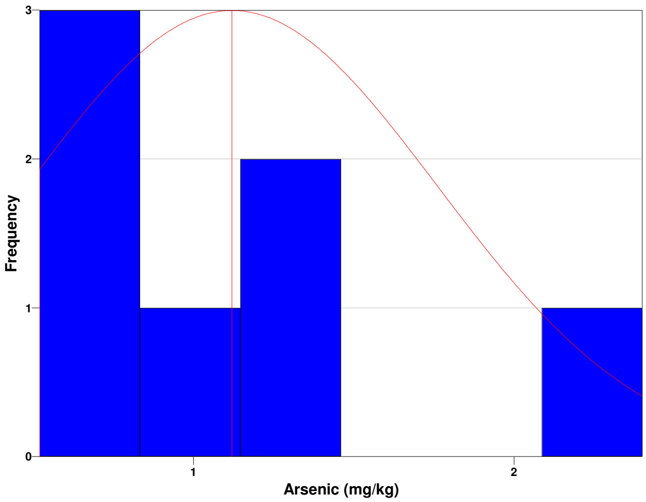
Data Plots for Arsenic
Graphical displays of the data are shown below.

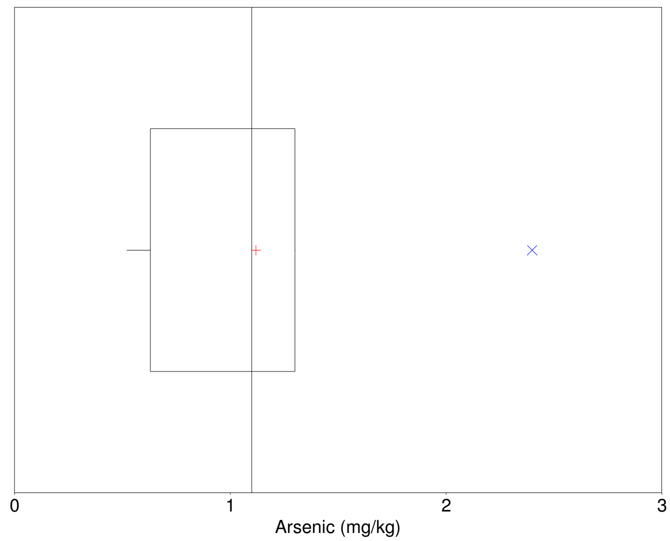
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

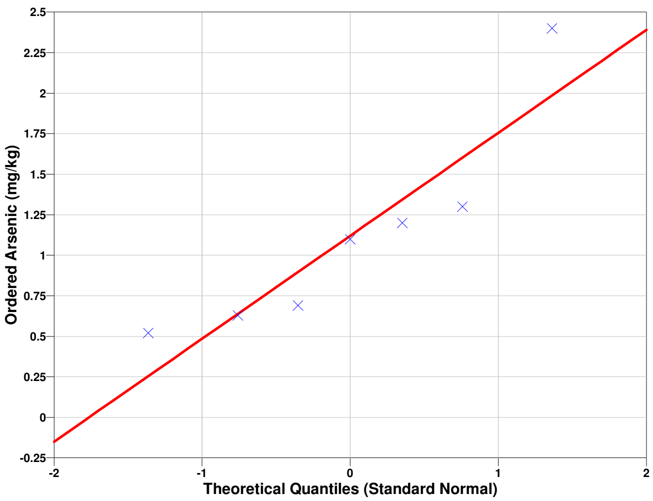
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight

line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Arsenic
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8495
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN

95% Parametric UCL	1.591
95% Non-Parametric (Chebyshev) UCL	2.175

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (1.591) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
3.0163	1.9432	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Data Analysis for Barium
The following data points were entered by the user for analysis.

Barium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	17.9	21.6	22.3	24.3	45.5	45.7	209			

SUMMARY STATISTICS for Barium	
n	7
Min	17.9
Max	209
Range	191.1
Mean	55.186
Median	24.3
Variance	4732.7
StdDev	68.795
Std Error	26.002
Skewness	2.4958
Interquartile Range	24.1
Percentiles	

1%	5%	10%	25%	50%	75%	90%	95%	99%
17.9	17.9	17.9	21.6	24.3	45.7	209	209	209

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Barium	
Dixon Test Statistic	0.019362
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 17.9 is not an outlier at the 10% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6209
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic is less than the 10% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 17.9, do not appear to follow a normal distribution at the 10% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

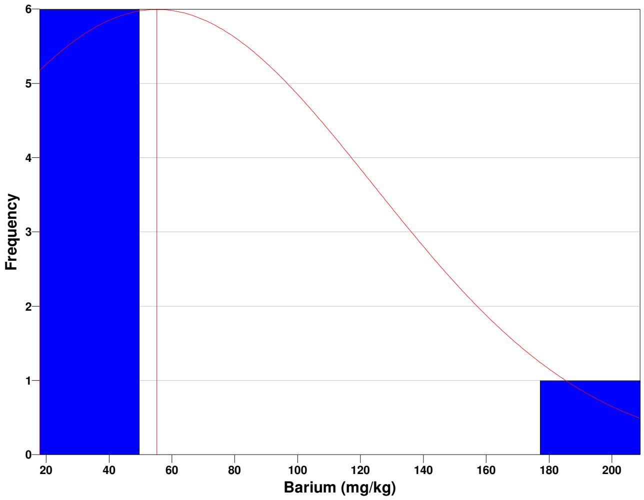
Data Plots for Barium
Graphical displays of the data are shown below.

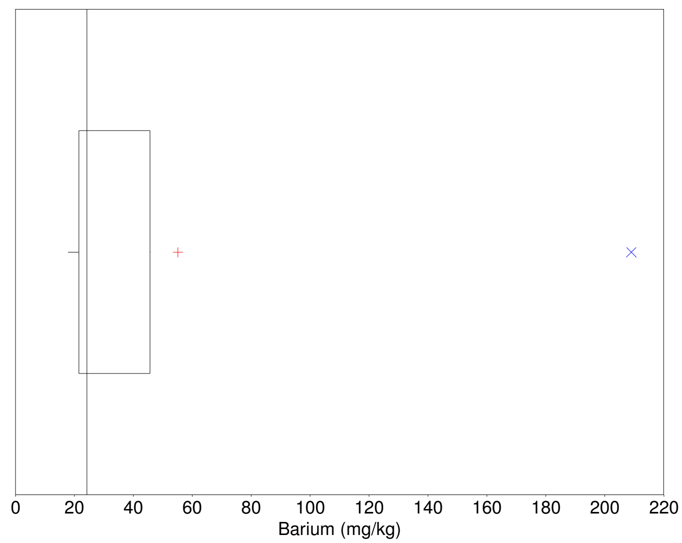
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

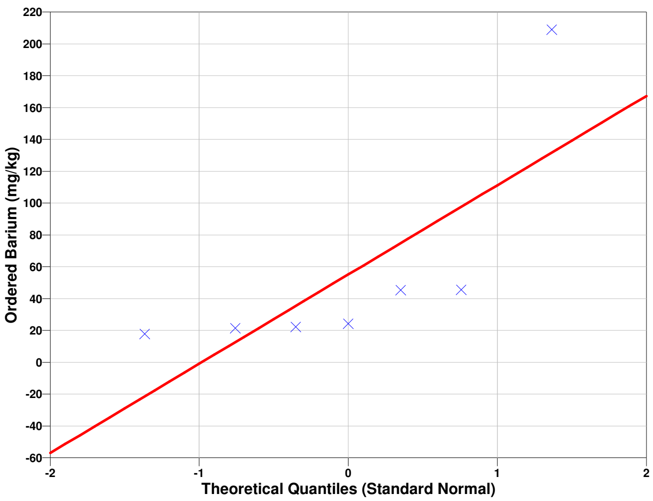
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight

line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Barium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5921
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN

95% Parametric UCL	105.7
95% Non-Parametric (Chebyshev) UCL	168.5

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (168.5) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-299.41	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Data Analysis for Beryllium
The following data points were entered by the user for analysis.

Beryllium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.098	0.13	0.14	0.18	0.19	0.19	0.2			

SUMMARY STATISTICS for Beryllium	
n	7
Min	0.098
Max	0.2
Range	0.102
Mean	0.16114
Median	0.18

Variance				0.0014891				
StdDev				0.038589				
Std Error				0.014585				
Skewness				-0.72264				
Interquartile Range				0.06				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.098	0.098	0.098	0.13	0.18	0.19	0.2	0.2	0.2

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Beryllium	
Dixon Test Statistic	0.31373
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.098 is not an outlier at the 10% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8383
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.098, do appear to follow a normal distribution at the 10% level of significance.

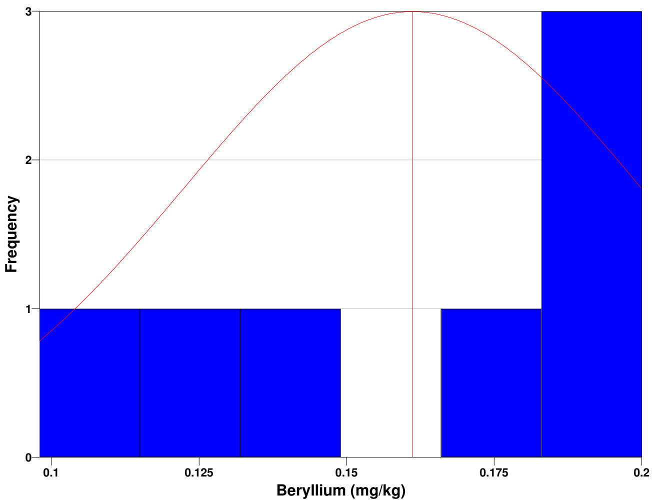
Data Plots for Beryllium
Graphical displays of the data are shown below.

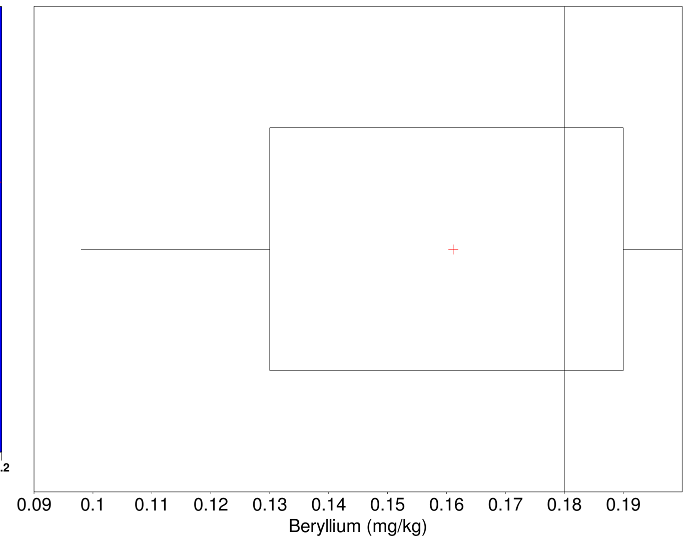
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

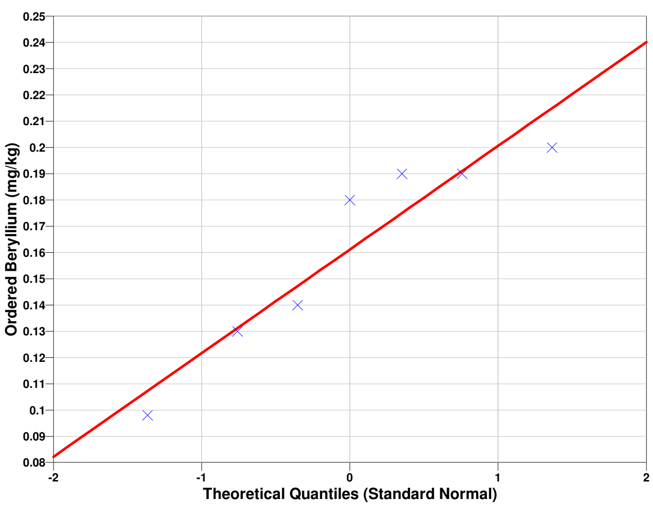
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the

distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Beryllium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8819
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.1895
95% Non-Parametric (Chebyshev) UCL	0.2247

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0.1895) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-2564.4	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Chromium
The following data points were entered by the user for analysis.

Chromium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	2.2	2.7	3.2	3.4	3.6	3.9	4			

SUMMARY STATISTICS for Chromium	
n	7
Min	2.2
Max	4
Range	1.8
Mean	3.2857
Median	3.4
Variance	0.42143
StdDev	0.64918

Std Error				0.24537				
Skewness				-0.72718				
Interquartile Range				1.2				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
2.2	2.2	2.2	2.7	3.4	3.9	4	4	4

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Chromium	
Dixon Test Statistic	0.27778
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 2.2 is not an outlier at the 10% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9558
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 2.2, do appear to follow a normal distribution at the 10% level of significance.

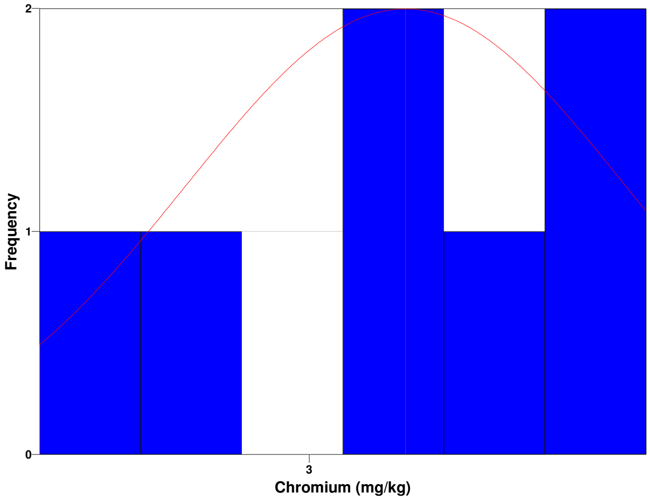
Data Plots for Chromium
Graphical displays of the data are shown below.

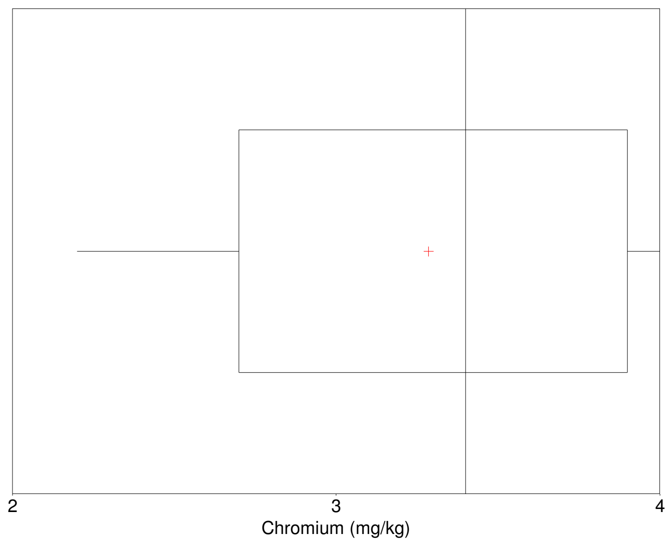
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

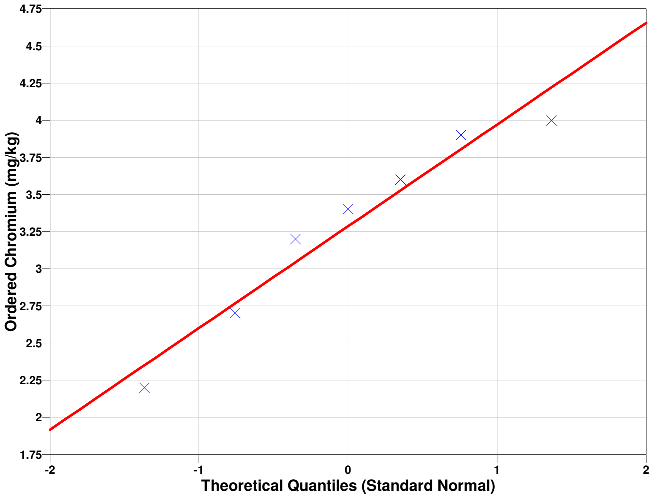
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the

Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Chromium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.94
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	3.763
95% Non-Parametric (Chebyshev) UCL	4.355

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (3.763) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-845.23	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Cobalt
The following data points were entered by the user for analysis.

Cobalt (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.6	0.63	0.8	0.81	0.88	1.1	1.1			

SUMMARY STATISTICS for Cobalt	
n	7
Min	0.6
Max	1.1
Range	0.5
Mean	0.84571
Median	0.81
Variance	0.040129
StdDev	0.20032
Std Error	0.075714
Skewness	0.22963
Interquartile Range	0.47

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.6	0.6	0.6	0.63	0.81	1.1	1.1	1.1	1.1

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Cobalt	
Dixon Test Statistic	0.06
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.6 is not an outlier at the 10% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9047
Shapiro-Wilk 10% Critical Value	0.826

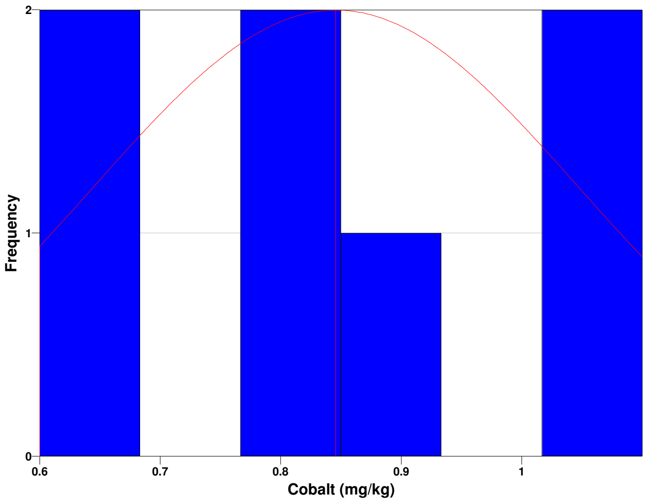
The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.6, do appear to follow a normal distribution at the 10% level of significance.

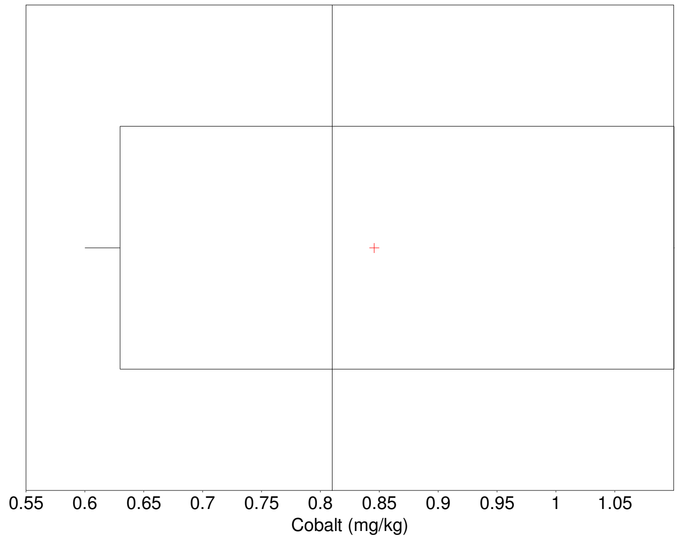
Data Plots for Cobalt
Graphical displays of the data are shown below.

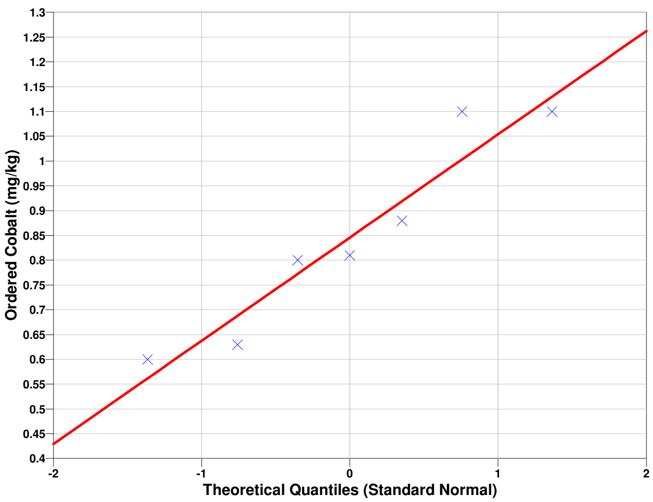
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Cobalt

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8993
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.9928

95% Non-Parametric (Chebyshev) UCL	1.176

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0.9928) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-11914	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Copper
The following data points were entered by the user for analysis.

Copper (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1.3	1.9	2	2	2.3	2.6	5			

SUMMARY STATISTICS for Copper								
n	7							
Min	1.3							
Max	5							
Range	3.7							
Mean	2.4429							
Median	2							
Variance	1.4295							
StdDev	1.1956							
Std Error	0.4519							
Skewness	2.0335							
Interquartile Range	0.7							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**

1.3	1.3	1.3	1.9	2	2.6	5	5	5

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Copper	
Dixon Test Statistic	0.16216
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 1.3 is not an outlier at the 10% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6789
Shapiro-Wilk 10% Critical Value	0.826

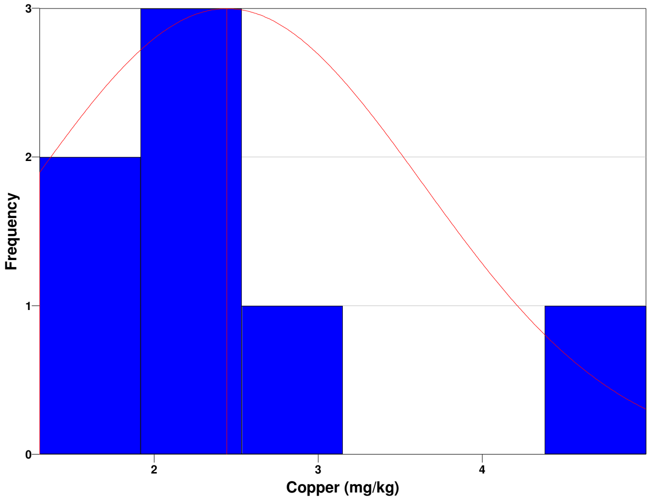
The calculated Shapiro-Wilk test statistic is less than the 10% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 1.3, do not appear to follow a normal distribution at the 10% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

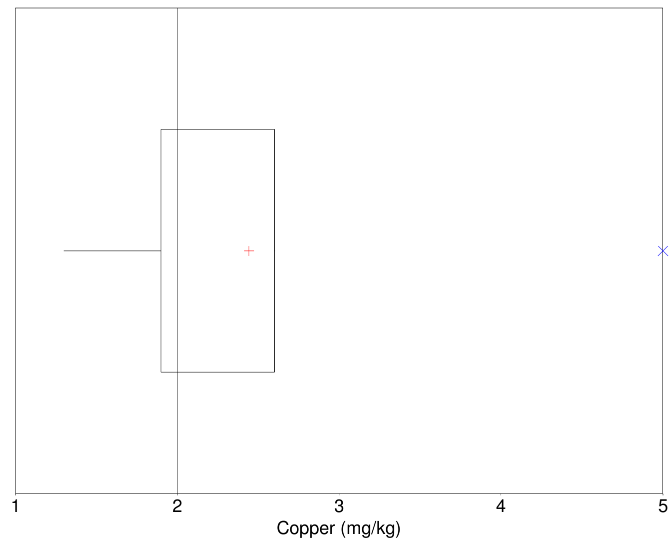
Data Plots for Copper
Graphical displays of the data are shown below.

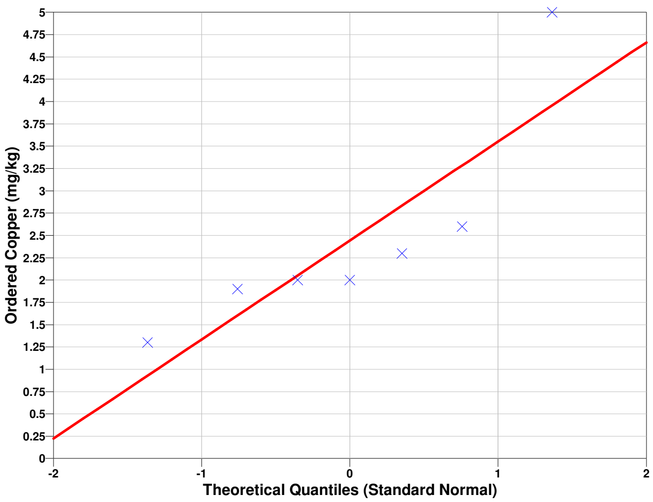
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Copper
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7643
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	3.321

95% Non-Parametric (Chebyshev) UCL	4.413

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (4.413) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1206.3	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Data Analysis for Lead
The following data points were entered by the user for analysis.

Lead (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	2.4	2.5	2.7	2.8	3.1	3.1	4.3			

SUMMARY STATISTICS for Lead	
n	7
Min	2.4
Max	4.3
Range	1.9
Mean	2.9857
Median	2.8
Variance	0.4081

StdDev				0.63882				
Std Error				0.24145				
Skewness				1.7256				
Interquartile Range				0.6				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
2.4	2.4	2.4	2.5	2.8	3.1	4.3	4.3	4.3

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Lead	
Dixon Test Statistic	0.052632
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 2.4 is not an outlier at the 10% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8201
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic is less than the 10% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 2.4, do not appear to follow a normal distribution at the 10% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

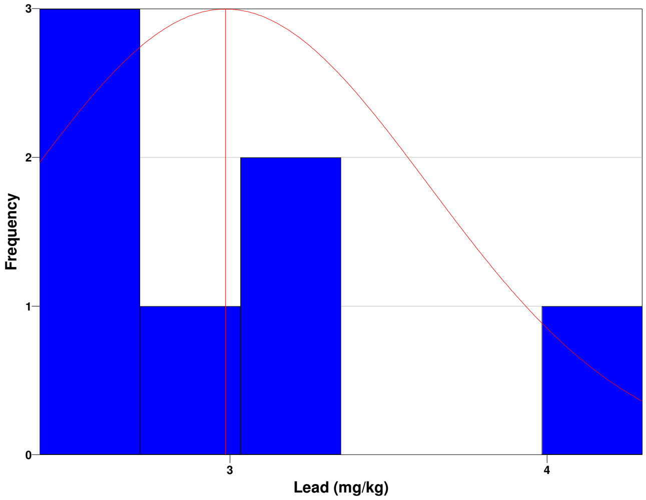
Data Plots for Lead
Graphical displays of the data are shown below.

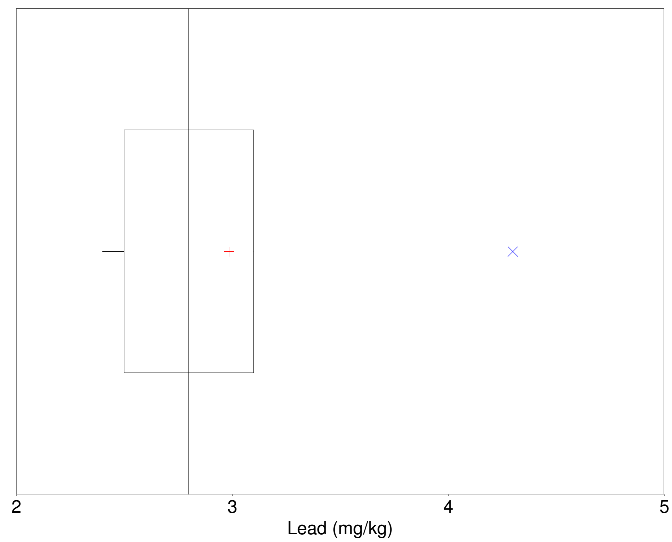
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

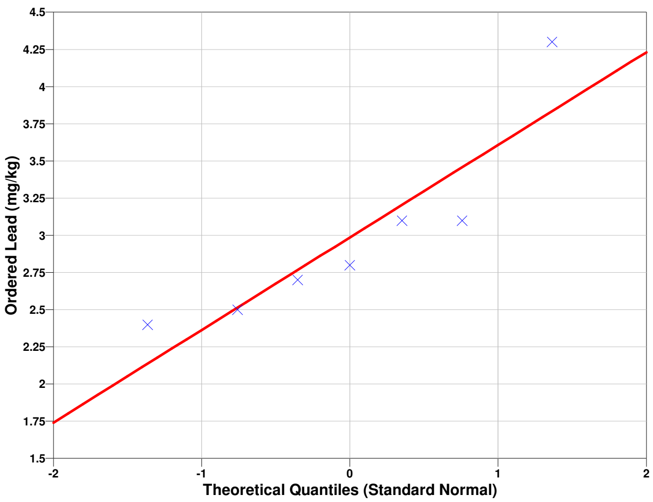
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted

individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Lead

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.826
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	3.455
95% Non-Parametric (Chebyshev) UCL	4.038

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (3.455) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1644.3	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Manganese
The following data points were entered by the user for analysis.

Manganese (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	26.9	41.4	42.2	76.3	95.5	113	114			

SUMMARY STATISTICS for Manganese	
n	7
Min	26.9
Max	114
Range	87.1
Mean	72.757
Median	76.3
Variance	1311.7

StdDev				36.217				
Std Error				13.689				
Skewness				-0.042551				
Interquartile Range				71.6				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
26.9	26.9	26.9	41.4	76.3	113	114	114	114

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Manganese	
Dixon Test Statistic	0.16648
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 26.9 is not an outlier at the 10% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8596
Shapiro-Wilk 10% Critical Value	0.826

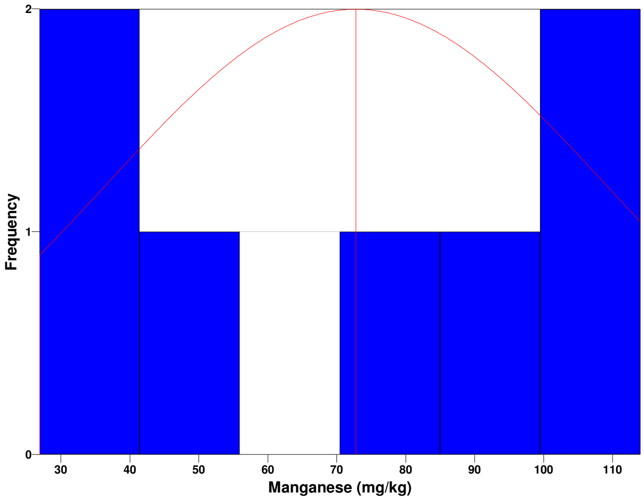
The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 26.9, do appear to follow a normal distribution at the 10% level of significance.

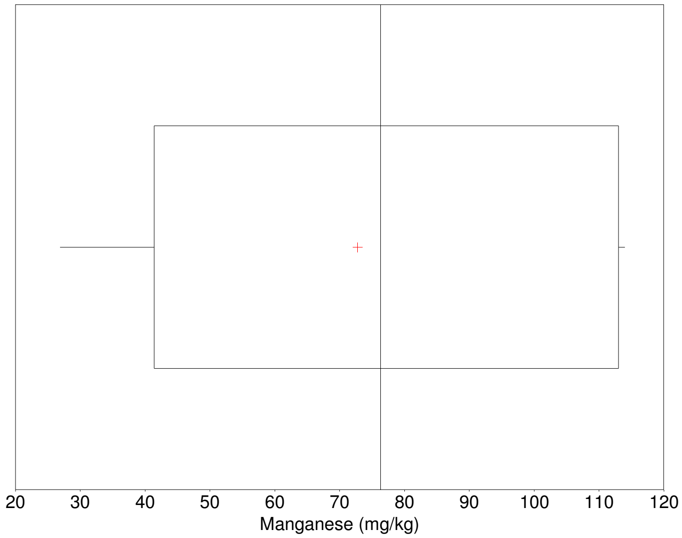
Data Plots for Manganese
Graphical displays of the data are shown below.

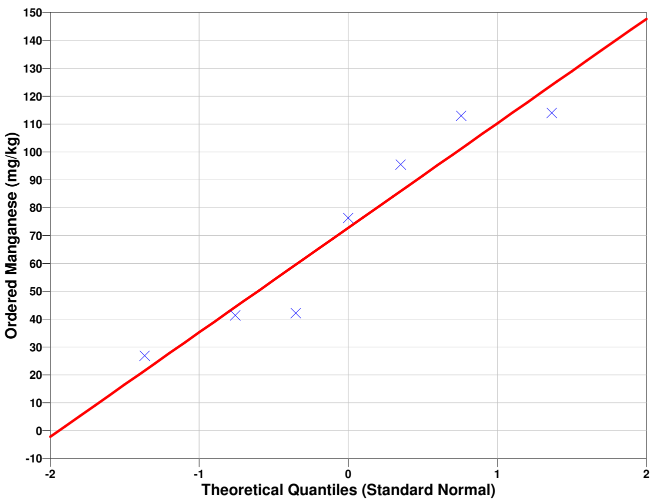
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Manganese

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.885
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that

assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	99.36
95% Non-Parametric (Chebyshev) UCL	132.4

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (99.36) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-231.32	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Mercury
The following data points were entered by the user for analysis.

Mercury (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.002	0.0023	0.0059	0.0065	0.012	0.033	0.034			

SUMMARY STATISTICS for Mercury	
n	7
Min	0.002
Max	0.034
Range	0.032
Mean	0.013671
Median	0.0065
Variance	0.0001945
StdDev	0.013946
Std Error	0.0052712
Skewness	1.008

Interquartile Range				0.0307				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.002	0.002	0.002	0.0023	0.0065	0.033	0.034	0.034	0.034

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Mercury	
Dixon Test Statistic	0.009375
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.002 is not an outlier at the 10% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8042
Shapiro-Wilk 10% Critical Value	0.826

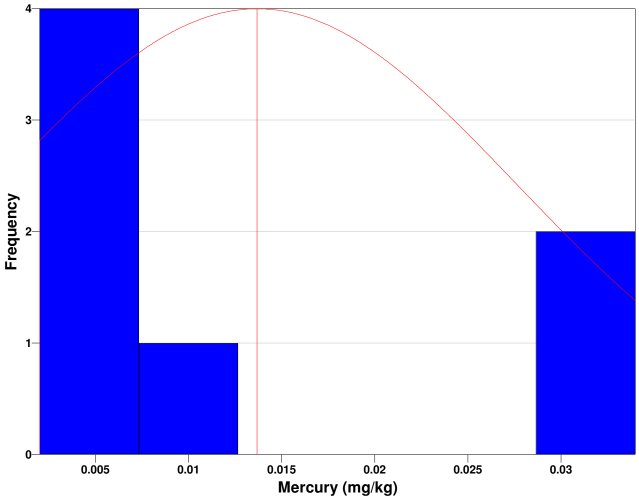
The calculated Shapiro-Wilk test statistic is less than the 10% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.002, do not appear to follow a normal distribution at the 10% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

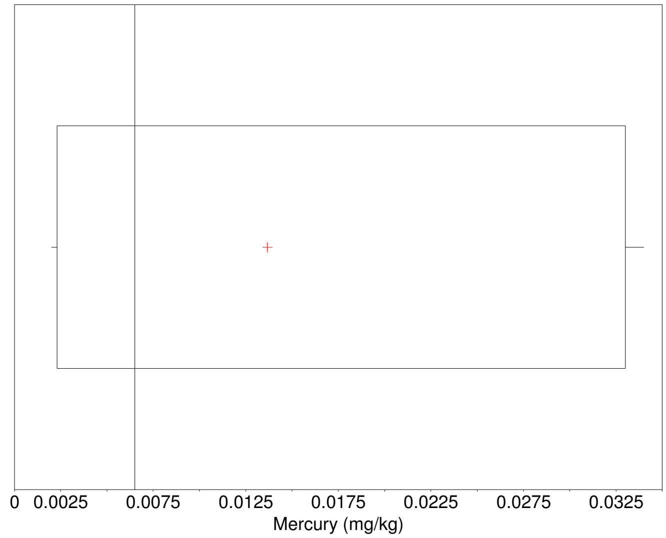
Data Plots for Mercury
Graphical displays of the data are shown below.

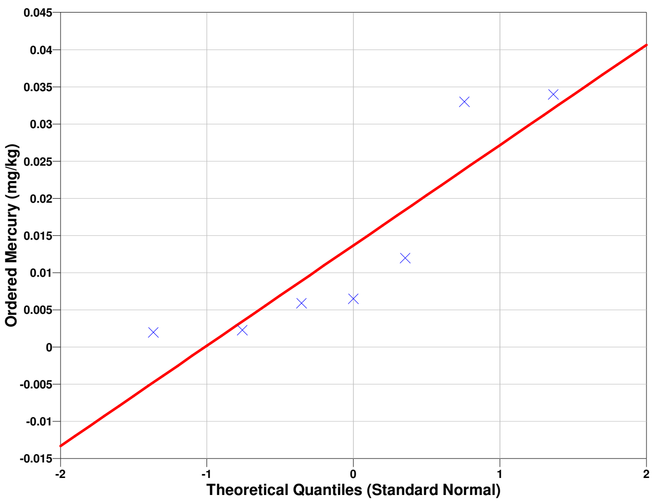
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Mercury

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7766
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that

assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.02391
95% Non-Parametric (Chebyshev) UCL	0.03665

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.03665) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-393.37	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Data Analysis for Nickel
The following data points were entered by the user for analysis.

Nickel (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1.2	1.2	1.4	1.6	1.8	1.9	2.3			

SUMMARY STATISTICS for Nickel	
n	7
Min	1.2
Max	2.3

Range	1.1
Mean	1.6286
Median	1.6
Variance	0.16238
StdDev	0.40297
Std Error	0.15231
Skewness	0.56458
Interquartile Range	0.7

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
1.2	1.2	1.2	1.2	1.6	1.9	2.3	2.3	2.3

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Nickel	
Dixon Test Statistic	0
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 1.2 is not an outlier at the 10% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.985
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 1.2, do appear to follow a normal distribution at the 10% level of significance.

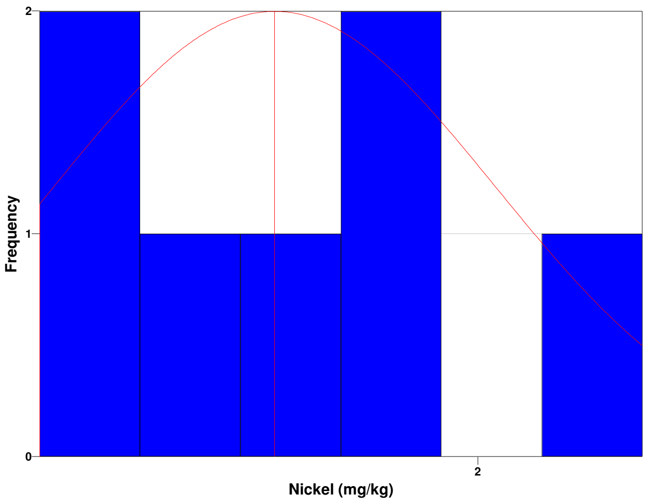
Data Plots for Nickel
Graphical displays of the data are shown below.

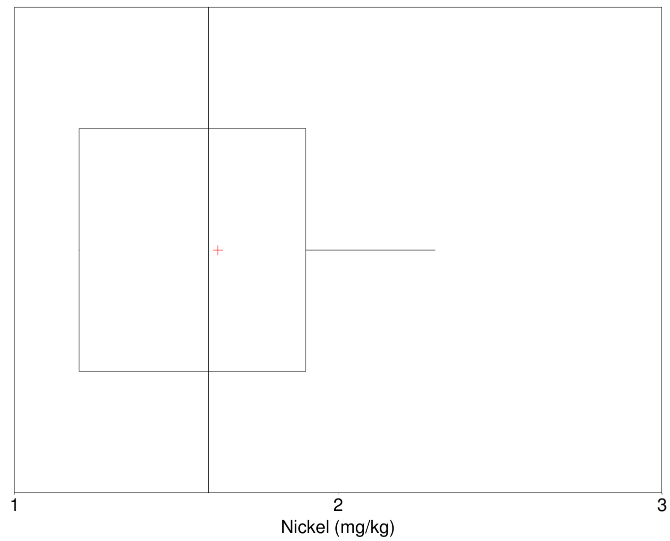
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

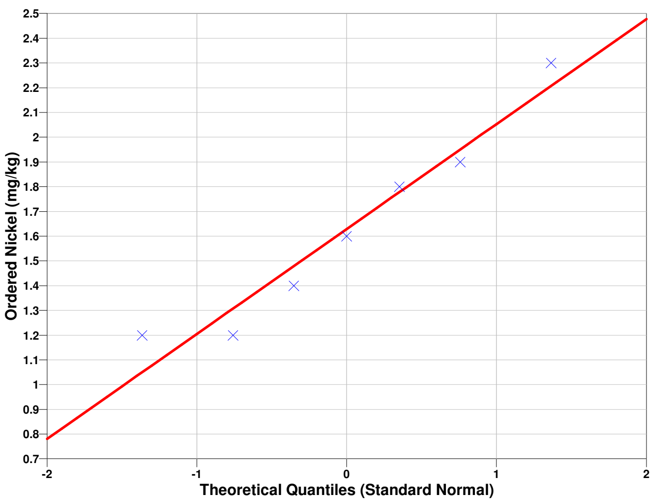
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends

to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Nickel

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9338
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	1.925
95% Non-Parametric (Chebyshev) UCL	2.292

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (1.925) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-5452.7	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Toluene
The following data points were entered by the user for analysis.

Toluene (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00075	0.00075	0.00075	0.0016	0.0017	0.0017	0.0018			

SUMMARY STATISTICS for Toluene	
n	7
Min	0.00075
Max	0.0018
Range	0.00105
Mean	0.0012929

Median				0.0016				
Variance				2.6119e-007				
StdDev				0.00051107				
Std Error				0.00019317				
Skewness				-0.32432				
Interquartile Range				0.00095				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00075	0.00075	0.00075	0.00075	0.0016	0.0017	0.0018	0.0018	0.0018

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Toluene	
Dixon Test Statistic	0
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.00075 is not an outlier at the 10% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7386
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic is less than the 10% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.00075, do not appear to follow a normal distribution at the 10% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

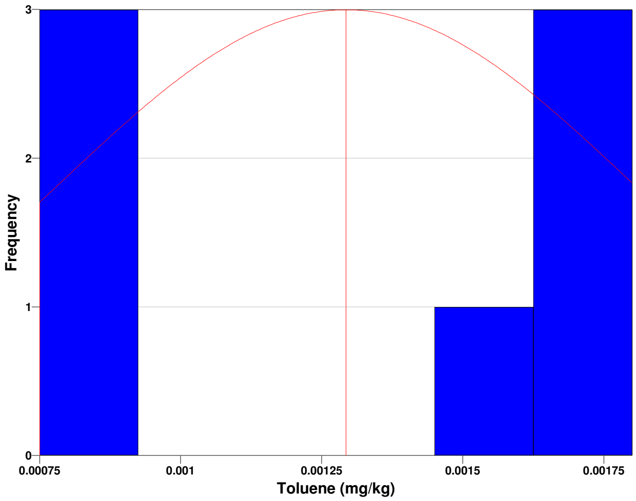
Data Plots for Toluene
Graphical displays of the data are shown below.

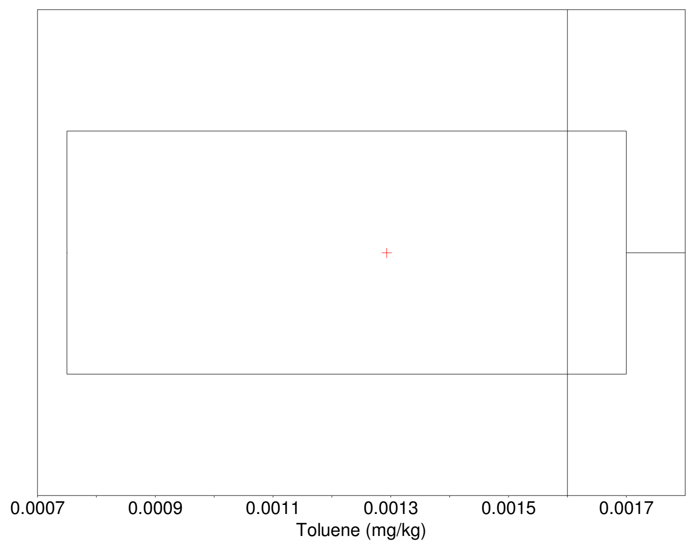
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

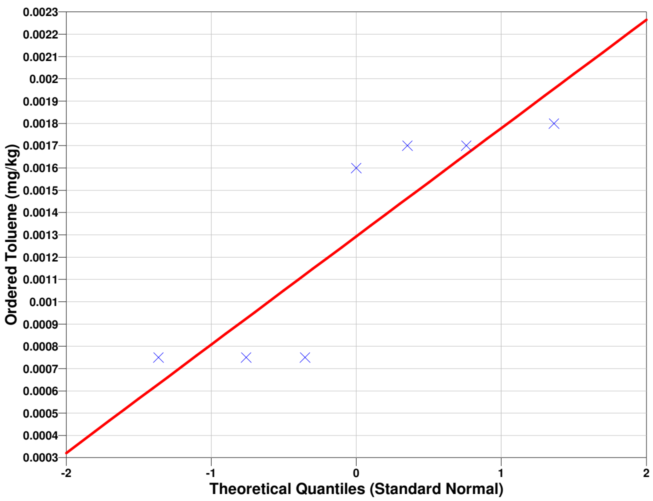
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles,

respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Toluene

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7381

Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.001668
95% Non-Parametric (Chebyshev) UCL	0.002135

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.002135) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-2.698e+006	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Data Analysis for Vanadium
The following data points were entered by the user for analysis.

Vanadium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	4.4	4.5	4.6	5.1	5.3	5.5	7.9			

SUMMARY STATISTICS for Vanadium								
n	7							
Min	4.4							
Max	7.9							
Range	3.5							
Mean	5.3286							
Median	5.1							
Variance	1.4624							
StdDev	1.2093							
Std Error	0.45707							
Skewness	2.0108							
Interquartile Range	1							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
4.4	4.4	4.4	4.5	5.1	5.5	7.9	7.9	7.9

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Vanadium	
Dixon Test Statistic	0.028571
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 4.4 is not an outlier at the 10% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7768
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic is less than the 10% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 4.4, do not appear to follow a normal distribution at the 10% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

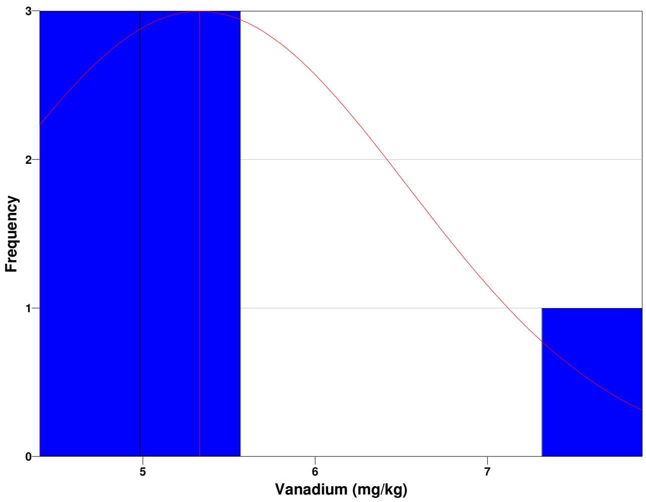
Data Plots for Vanadium
Graphical displays of the data are shown below.

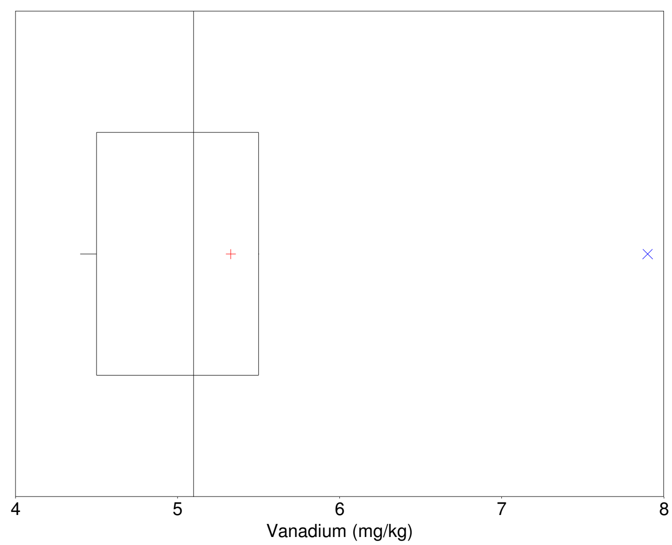
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

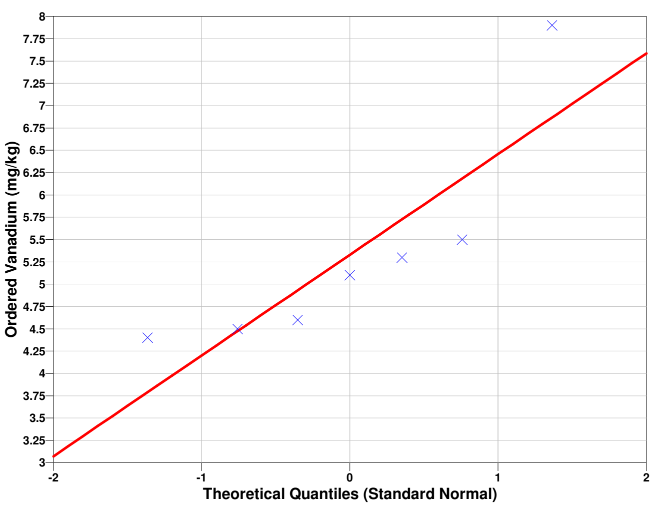
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Vanadium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7602
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	6.217
95% Non-Parametric (Chebyshev) UCL	7.321

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (7.321) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-625.04	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Data Analysis for Zinc
The following data points were entered by the user for analysis.

Zinc (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	8.9	10.2	11.9	13.7	17.5	18.2	35.8			

SUMMARY STATISTICS for Zinc								
n	7							
Min	8.9							
Max	35.8							
Range	26.9							
Mean	16.6							
Median	13.7							
Variance	83.793							
StdDev	9.1539							
Std Error	3.4598							
Skewness	1.897							
Interquartile Range	8							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
8.9	8.9	8.9	10.2	13.7	18.2	35.8	35.8	35.8

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Zinc	
Dixon Test Statistic	0.048327
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 8.9 is not an outlier at the 10% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7948
Shapiro-Wilk 10% Critical Value	0.826

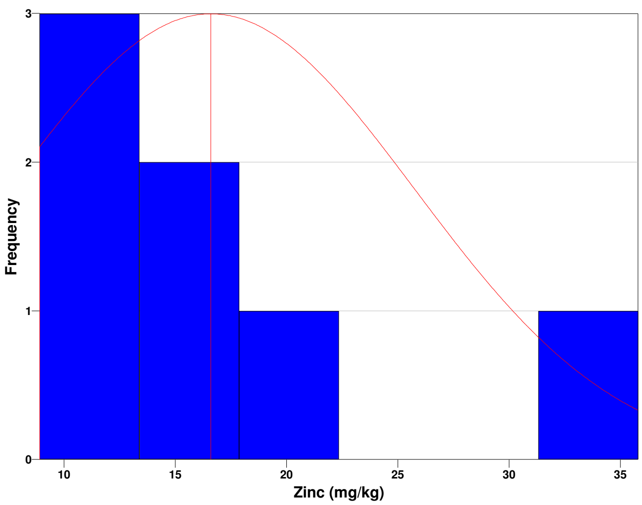
The calculated Shapiro-Wilk test statistic is less than the 10% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 8.9, do not appear to follow a normal distribution at the 10% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

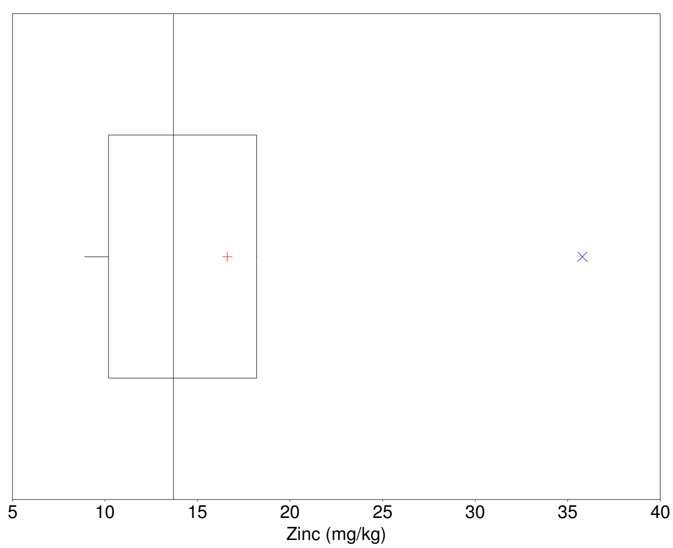
Data Plots for Zinc
Graphical displays of the data are shown below.

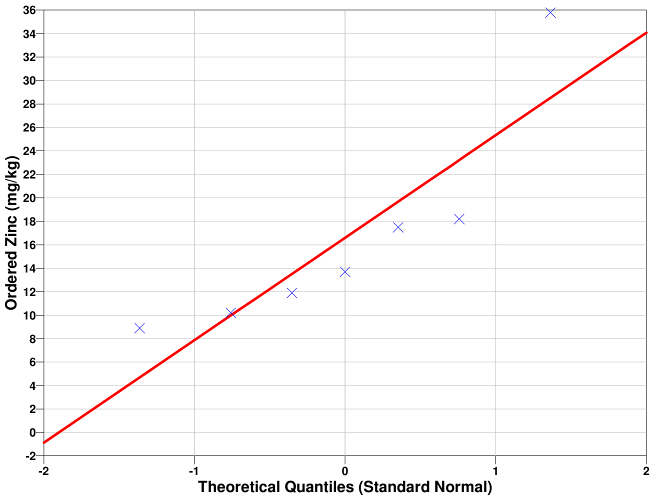
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Zinc
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7937
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	23.32
95% Non-Parametric (Chebyshev) UCL	31.68

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (31.68) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (9921.47),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-2862.8	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

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Software and documentation available at http://dqo.pnl.gov/vsp

* - The report contents may have been modified or reformatted by end-user of software.

Appendix C

VSP Reports of Calculated Minimum Sample Quantity
Report 16
Area of Concern – 3
Minimum Sample Quantity Calculation for Subsurface Soil using Human Health Benchmarks and Delta Method 2

Random sampling locations for comparing a mean with a fixed threshold (parametric)

Summary
This report summarizes the sampling design, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design for Arsenic, the driving analyte (the analyte which required the largest number of samples). A figure that shows sampling locations in the field and a table that lists sampling location coordinates are also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean to a fixed threshold
Type of Sampling Design	Parametric
Sample Placement (Location) in the Field	Simple random sampling
Working (Null) Hypothesis	The mean value at the site exceeds the threshold
Formula for calculating number of sampling locations	Student's t-test
Calculated total number of samples	94
Number of samples on map [a]	94
Number of selected sample areas [b]	1
Specified sampling area [c]	602117.04 m^2
Total cost of sampling [d]	$48,000.00

[a] This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[d] Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.

Area: Area 1					
X Coord	**Y Coord**	**Label**	**Value**	**Type**	**Historical**
680077.3540	3083115.5330	J-50S		Manual	T
680141.8730	3083080.8800	J-52S		Manual	T
680170.5600	3083064.6740	J-53S		Manual	T

679924.8150	3082872.3490	J-47S		Manual	T
679994.9690	3082983.5100	J-48S		Manual	T
680057.6580	3083072.0750	J-49S		Manual	T
679827.1150	3082729.7460	J-51S		Manual	T
679502.0208	3082563.6317		0	Adaptive-Fill	
679850.4097	3083712.3338		0	Adaptive-Fill	
679722.9455	3083383.4215		0	Adaptive-Fill	
679544.9455	3082971.5536		0	Adaptive-Fill	
680042.1794	3083477.4213		0	Adaptive-Fill	
680358.2568	3083351.0365		0	Adaptive-Fill	
679768.8657	3083095.5271		0	Adaptive-Fill	
679936.7490	3083272.5249		0	Adaptive-Fill	
679629.1778	3082785.6975		0	Adaptive-Fill	
679639.2584	3083579.6793		0	Adaptive-Fill	
680148.3797	3083297.3779		0	Adaptive-Fill	
679715.2239	3082562.4570		0	Adaptive-Fill	
679608.7065	3082412.8027		0	Adaptive-Fill	
679845.6201	3083513.1704		0	Adaptive-Fill	
679559.9129	3083418.7973		0	Adaptive-Fill	
680205.9386	3083452.1059		0	Adaptive-Fill	
679744.1059	3082909.8756		0	Adaptive-Fill	
679611.6422	3083117.3095		0	Adaptive-Fill	
680272.3151	3083195.9418		0	Adaptive-Fill	
679487.2618	3082729.4561		0	Adaptive-Fill	
679794.4711	3083245.1554		0	Adaptive-Fill	
679986.9931	3083607.6783		0	Adaptive-Fill	
679603.5733	3082659.0821		0	Adaptive-Fill	
679856.5074	3083379.1719		0	Adaptive-Fill	
679869.8653	3083002.2126		0	Adaptive-Fill	
679907.8157	3083137.8228		0	Adaptive-Fill	
679726.2265	3083681.5047		0	Adaptive-Fill	
679683.2902	3083009.3950		0	Adaptive-Fill	
679995.3342	3083371.0596		0	Adaptive-Fill	
679396.8429	3082597.4012		0	Adaptive-Fill	
679736.5671	3083502.4932		0	Adaptive-Fill	
680070.7933	3083229.6315		0	Adaptive-Fill	
680170.7663	3083184.7239		0	Adaptive-Fill	
679703.4902	3082715.8877		0	Adaptive-Fill	
679606.9575	3082549.6117		0	Adaptive-Fill	
679818.8756	3083609.3326		0	Adaptive-Fill	
680250.0508	3083334.7673		0	Adaptive-Fill	

679689.8958	3083220.0478		0	Adaptive-Fill	
679644.7966	3082908.6075		0	Adaptive-Fill	
679940.7513	3083460.5250		0	Adaptive-Fill	
679761.3910	3083768.5958		0	Adaptive-Fill	
680090.8918	3083380.6607		0	Adaptive-Fill	
679829.5553	3082880.2864		0	Adaptive-Fill	
680129.0236	3083514.7818		0	Adaptive-Fill	
679643.5486	3083430.7727		0	Adaptive-Fill	
679725.3409	3082804.0523		0	Adaptive-Fill	
679554.9700	3082480.6051		0	Adaptive-Fill	
679591.9307	3083510.7484		0	Adaptive-Fill	
679989.6362	3083156.1017		0	Adaptive-Fill	
679577.6806	3082859.4968		0	Adaptive-Fill	
679896.3996	3083633.9791		0	Adaptive-Fill	
679689.9525	3083133.7559		0	Adaptive-Fill	
680325.6951	3083277.4688		0	Adaptive-Fill	
679483.5061	3082648.3800		0	Adaptive-Fill	
679740.1895	3083303.7798		0	Adaptive-Fill	
680281.4630	3083418.9611		0	Adaptive-Fill	
679924.4763	3083555.6563		0	Adaptive-Fill	
679831.3223	3083153.9620		0	Adaptive-Fill	
679772.8391	3082622.2619		0	Adaptive-Fill	
680066.9840	3083305.0773		0	Adaptive-Fill	
679868.4043	3082806.5658		0	Adaptive-Fill	
679679.3946	3082496.6661		0	Adaptive-Fill	
679939.4633	3083067.7094		0	Adaptive-Fill	
679862.7880	3083077.3454		0	Adaptive-Fill	
679777.8192	3083024.8102		0	Adaptive-Fill	
679869.4543	3083291.5269		0	Adaptive-Fill	
679674.4987	3082634.3823		0	Adaptive-Fill	
679721.5018	3083582.5457		0	Adaptive-Fill	
680158.4293	3083380.3541		0	Adaptive-Fill	
679759.0047	3083172.7583		0	Adaptive-Fill	
680231.2866	3083249.5634		0	Adaptive-Fill	
680125.2687	3083449.4411		0	Adaptive-Fill	
679449.6708	3082510.4796		0	Adaptive-Fill	
679802.9509	3083412.6498		0	Adaptive-Fill	
679990.3662	3083243.3554		0	Adaptive-Fill	
680054.9525	3083565.8058		0	Adaptive-Fill	
679573.8637	3082760.3696		0	Adaptive-Fill	
679881.1306	3083209.5083		0	Adaptive-Fill	

679546.5036	3082619.1763		0	Adaptive-Fill	
679611.9381	3082963.6827		0	Adaptive-Fill	
680005.9275	3083433.1182		0	Adaptive-Fill	
679582.9535	3083040.2352		0	Adaptive-Fill	
679813.5365	3083297.8505		0	Adaptive-Fill	
680201.6885	3083134.0390		0	Adaptive-Fill	
679672.2384	3083533.1774		0	Adaptive-Fill	
679784.8917	3082840.8724		0	Adaptive-Fill	
679864.0152	3083461.2502		0	Adaptive-Fill	

Primary Sampling Objective
The primary purpose of sampling at this site is to compare a mean value of a site with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the mean value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the mean value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative hypothesis, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach
A parametric random sampling approach was used to determine the number of samples and to specify sampling locations. A parametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that parametric assumptions are reasonable. These assumptions will be examined in post-sampling data analysis.

Both parametric and non-parametric approaches rely on assumptions about the population. However, non-parametric approaches typically require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than the number of samples required by non-parametric approaches.

Locating the sample points randomly provides data that are separated by many distances, whereas systematic samples are all equidistant apart. Therefore, random sampling provides more information about the spatial structure of the potential contamination than systematic sampling does. As with systematic sampling, random sampling also provides information regarding the mean value, but there is the possibility that areas of the site will not be represented with the same frequency as if uniform grid sampling were performed.

Number of Total Samples: Calculation Equation and Inputs
The equation used to calculate the number of samples is based on a Student's t-test. For this site, the null hypothesis is rejected in favor of the alternative hypothesis if the sample mean is sufficiently smaller than the threshold. The number of samples to collect is calculated so that 1) there will be a high probability ($1-\beta$) of rejecting the null hypothesis if the alternative hypothesis is true and 2) a low probability (α) of rejecting the null hypothesis if the null hypothesis is true.

The formula used to calculate the number of samples is:

$$n = \frac{S^2}{\Delta^2}\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2 + 0.5Z_{1-\alpha}^2$$

where
n is the number of samples,
S is the estimated standard deviation of the measured values including analytical error,
Δ is the width of the gray region,
α is the acceptable probability of incorrectly concluding the site mean is less than the threshold,
β is the acceptable probability of incorrectly concluding the site mean exceeds the threshold,
$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is $1-\alpha$,
$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is $1-\beta$.

The values of these inputs that result in the calculated number of sampling locations are:

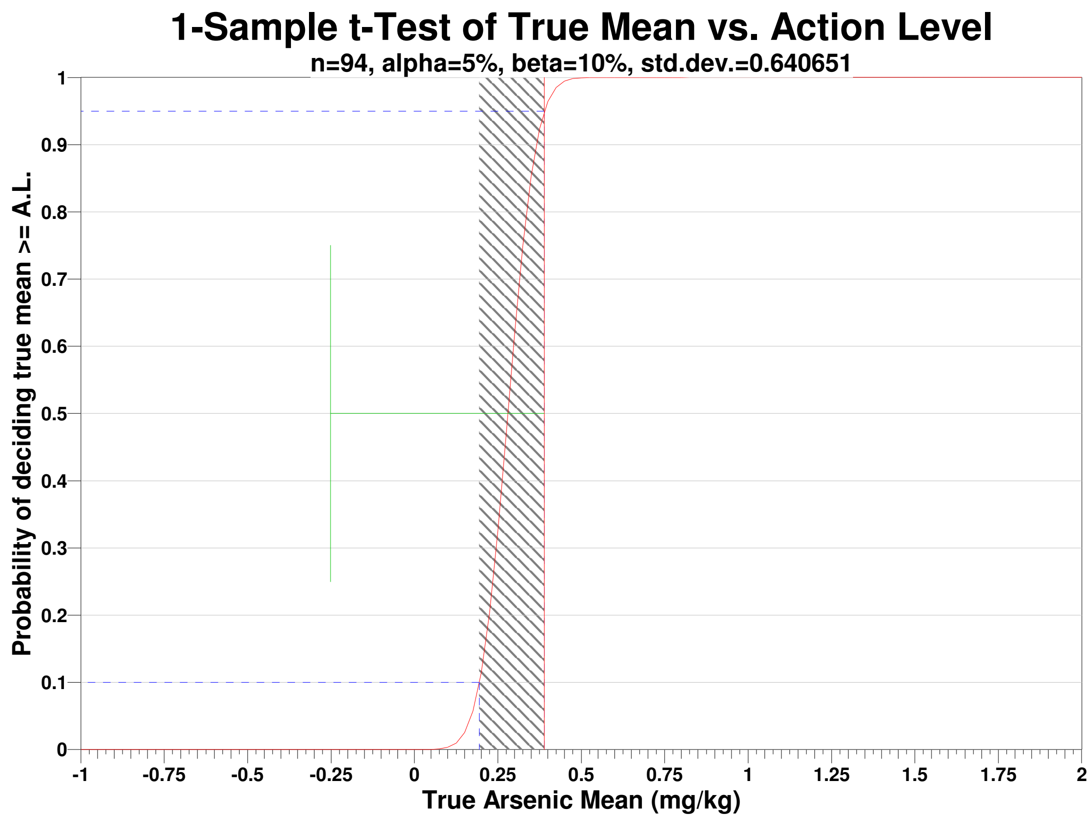
Analyte	n	Parameter

	S	Δ	α	β	$Z_{1-\alpha}$ [a]	$Z_{1-\beta}$ [b]	
New Location	2	0.1 mg/kg	10 mg/kg	0.05	0.1	1.64485	1.28155
Acetone	2	0.0244015 mg/kg	2708.71 mg/kg	0.05	0.1	1.64485	1.28155
Aluminum	2	776.733 mg/kg	3260.58 mg/kg	0.05	0.1	1.64485	1.28155
Arsenic	94	0.640651 mg/kg	0.194812 mg/kg	0.05	0.1	1.64485	1.28155
Barium	2	68.7947 mg/kg	3920.25 mg/kg	0.05	0.1	1.64485	1.28155
Beryllium	2	0.0385894 mg/kg	18.7822 mg/kg	0.05	0.1	1.64485	1.28155
Chromium	2	0.649175 mg/kg	105.338 mg/kg	0.05	0.1	1.64485	1.28155
Cobalt	2	0.200321 mg/kg	451.447 mg/kg	0.05	0.1	1.64485	1.28155
Copper	2	1.19563 mg/kg	273.798 mg/kg	0.05	0.1	1.64485	1.28155
Lead	2	0.638823 mg/kg	200 mg/kg	0.05	0.1	1.64485	1.28155
Manganese	2	36.2173 mg/kg	1619.65 mg/kg	0.05	0.1	1.64485	1.28155
Mercury	2	0.0139463 mg/kg	1.04361 mg/kg	0.05	0.1	1.64485	1.28155
Nickel	2	0.402965 mg/kg	416.052 mg/kg	0.05	0.1	1.64485	1.28155
Toluene	2	0.000511068 mg/kg	260.585 mg/kg	0.05	0.1	1.64485	1.28155
Vanadium	2	1.20929 mg/kg	145.507 mg/kg	0.05	0.1	1.64485	1.28155
Zinc	2	9.15387 mg/kg	4960.74 mg/kg	0.05	0.1	1.64485	1.28155

[a] This value is automatically calculated by VSP based upon the user defined value of α.
[b] This value is automatically calculated by VSP based upon the user defined value of β.

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000) for Arsenic, the driving analyte. It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true mean values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at 1-α on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at 1-α. If any of the inputs change, the number of samples that result in the correct curve changes.



Statistical Assumptions
The assumptions associated with the formulas for computing the number of samples are:
1. the sample mean is normally distributed (this happens if the data are roughly symmetric or the sample size is more than 30; for extremely skewed data sets, additional samples may be required for the sample mean to be normally distributed),
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected randomly.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the sample locations were selected using a random process.

Sensitivity Analysis
The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that μ > action level and alpha (%), probability of mistakenly concluding that μ < action level. The following table shows the results of this analysis.

Number of Samples							
AL=0.389624		α=5		α=10		α=15	
		s=1.2813	s=0.640651	s=1.2813	s=0.640651	s=1.2813	s=0.640651
LBGR=90	β=5	11706	2928	9263	2317	7776	1945
	β=10	9263	2317	7106	1777	5812	1454
	β=15	7777	1946	5812	1454	4648	1163
LBGR=80	β=5	2928	733	2317	580	1945	487
	β=10	2317	581	1777	445	1454	364
	β=15	1946	488	1454	364	1163	291
LBGR=70	β=5	1302	327	1030	259	865	217

	β=10	1031	259	791	199	647	162
	β=15	866	218	647	163	517	130

s = Standard Deviation
LBGR = Lower Bound of Gray Region (% of Action Level)
β = Beta (%), Probability of mistakenly concluding that μ > action level
α = Alpha (%), Probability of mistakenly concluding that μ < action level
AL = Action Level (Threshold)

Cost of Sampling
The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that are based on the number of samples collected and measured. Based on the numbers of samples determined above, the estimated total cost of sampling and analysis at this site is $48,000.00, which averages out to a per sample cost of $510.64. The following table summarizes the inputs and resulting cost estimates.

COST INFORMATION			
Cost Details	**Per Analysis**	**Per Sample**	**94 Samples**
Field collection costs		$100.00	$9,400.00
Analytical costs	$400.00	$400.00	$37,600.00
Sum of Field & Analytical costs		**$500.00**	**$47,000.00**
Fixed planning and validation costs			$1,000.00
Total cost			**$48,000.00**

Data Analysis for New Location
The following data points were entered by the user for analysis.

New Location (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0	0
80	0	0	0	0	0	0	0			

SUMMARY STATISTICS for New Location	
n	87
Min	0
Max	0
Range	0
Mean	0
Median	0

Variance				0				
StdDev				0				
Std Error				0				
Skewness				-1.#IND				
Interquartile Range				0				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0	0	0	0	0	0	0	0	0

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for New Location			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	-1.#IO	-1	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Lilliefors test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Lilliefors Test Statistic	0
Lilliefors 5% Critical Value	0.889

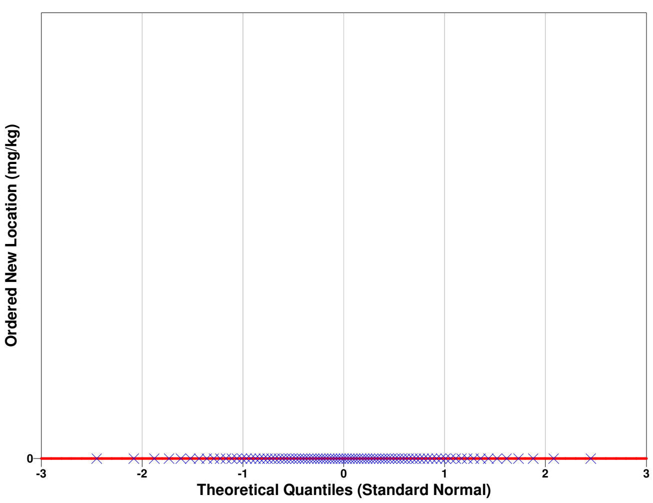
The calculated Lilliefors test statistic is less than the 5% Lilliefors critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

Data Plots for New Location
Graphical displays of the data are shown below.

The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.



For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for New Location

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Lilliefors test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST

Lilliefors Test Statistic	0
Lilliefors 5% Critical Value	0.09499

The calculated Lilliefors test statistic is less than the 5% Lilliefors critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0
95% Non-Parametric (Chebyshev) UCL	0

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=87 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=86 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.#IND	1.6628	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Data Analysis for Acetone
The following data points were entered by the user for analysis.

Acetone (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0094	0.0144	0.0164	0.0165	0.0305	0.0331	0.0804			

SUMMARY STATISTICS for Acetone	
n	7
Min	0.0094
Max	0.0804

Range	0.071							
Mean	0.028671							
Median	0.0165							
Variance	0.00059543							
StdDev	0.024401							
Std Error	0.0092229							
Skewness	2.0041							
Interquartile Range	0.0187							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0094	0.0094	0.0094	0.0144	0.0165	0.0331	0.0804	0.0804	0.0804

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Acetone	
Dixon Test Statistic	0.070423
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.0094 is not an outlier at the 10% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7448
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic is less than the 10% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.0094, do not appear to follow a normal distribution at the 10% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

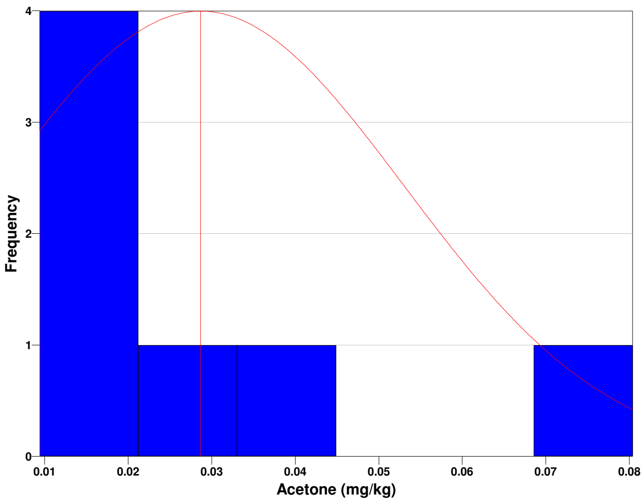
Data Plots for Acetone
Graphical displays of the data are shown below.

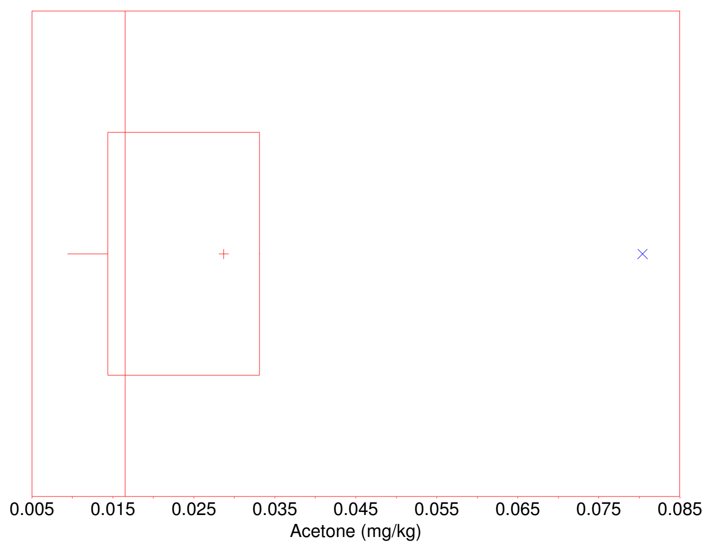
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

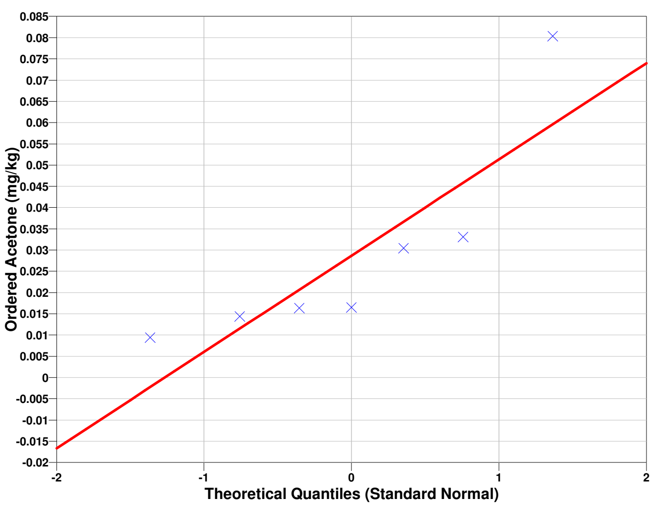
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box,

called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Acetone

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST

Shapiro-Wilk Test Statistic	0.7539
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.04659
95% Non-Parametric (Chebyshev) UCL	0.06887

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.06887) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-5.8738e+005	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Data Analysis for Aluminum
The following data points were entered by the user for analysis.

Aluminum (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

0	2400	3070	3290	3570	4210	4260	4600			

SUMMARY STATISTICS for Aluminum								
n	7							
Min	2400							
Max	4600							
Range	2200							
Mean	3628.6							
Median	3570							
Variance	6.0331e+005							
StdDev	776.73							
Std Error	293.58							
Skewness	-0.34987							
Interquartile Range	1190							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
2400	2400	2400	3070	3570	4260	4600	4600	4600

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Aluminum	
Dixon Test Statistic	0.30455
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 2400 is not an outlier at the 10% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9262
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 2400, do appear to follow a normal distribution at the 10% level of significance.

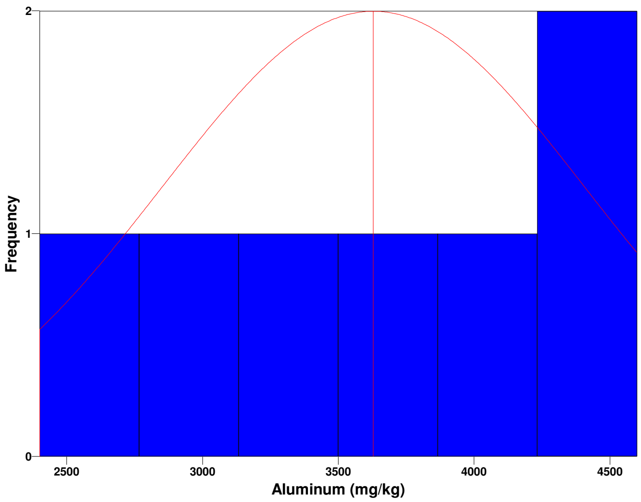
Data Plots for Aluminum
Graphical displays of the data are shown below.

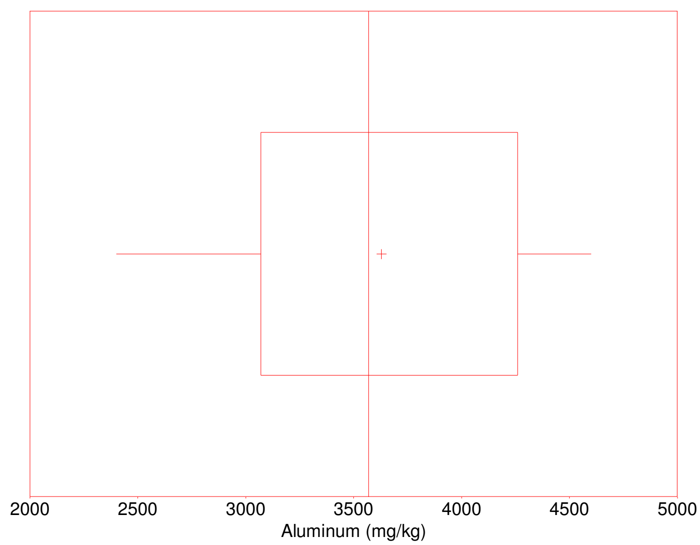
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

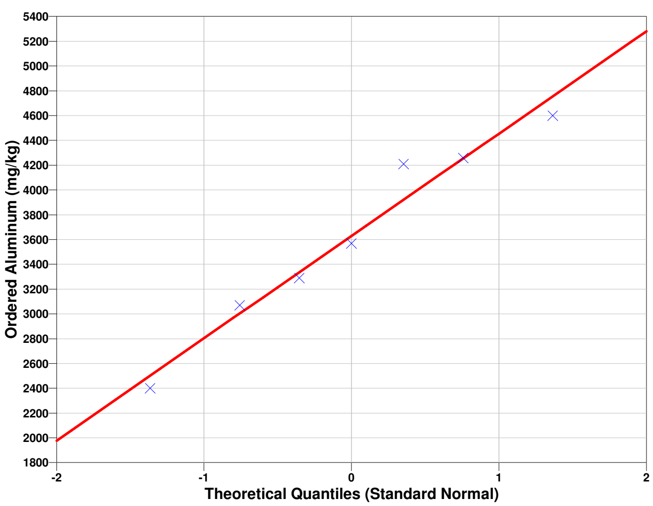
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Aluminum
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9566
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	4199
95% Non-Parametric (Chebyshev) UCL	4908

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (4199) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-9.8529	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Arsenic
The following data points were entered by the user for analysis.

Arsenic (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.52	0.63	0.69	1.1	1.2	1.3	2.4			

SUMMARY STATISTICS for Arsenic

n	7
Min	0.52
Max	2.4
Range	1.88
Mean	1.12
Median	1.1
Variance	0.41043
StdDev	0.64065
Std Error	0.24214
Skewness	1.5
Interquartile Range	0.67

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.52	0.52	0.52	0.63	1.1	1.3	2.4	2.4	2.4

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Arsenic	
Dixon Test Statistic	0.058511
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.52 is not an outlier at the 10% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8507
Shapiro-Wilk 10% Critical Value	0.826

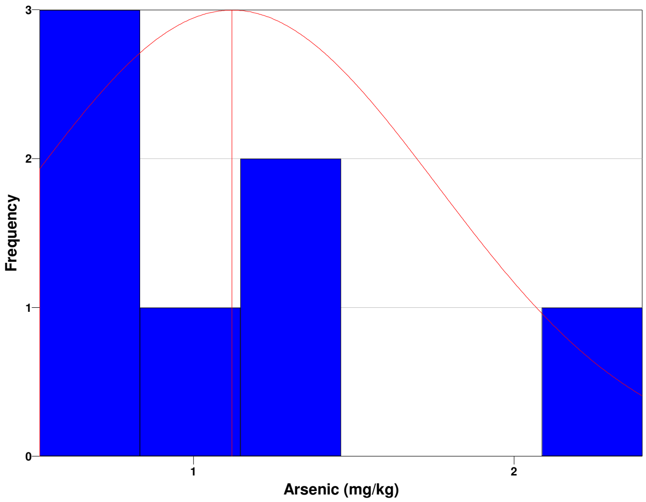
The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.52, do appear to follow a normal distribution at the 10% level of significance.

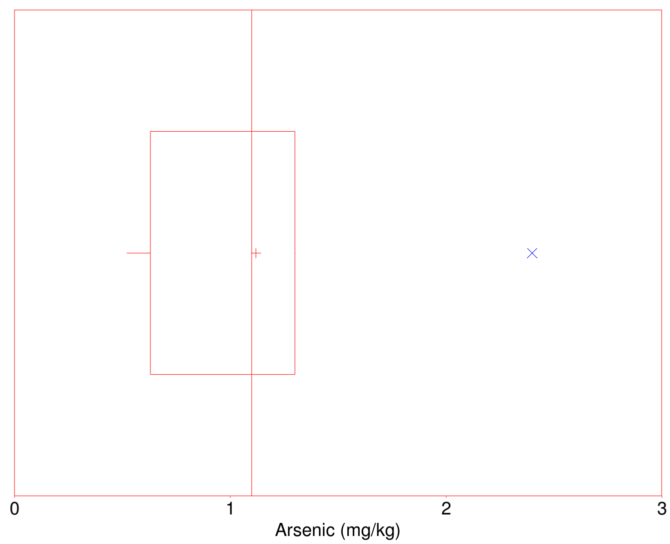
Data Plots for Arsenic
Graphical displays of the data are shown below.

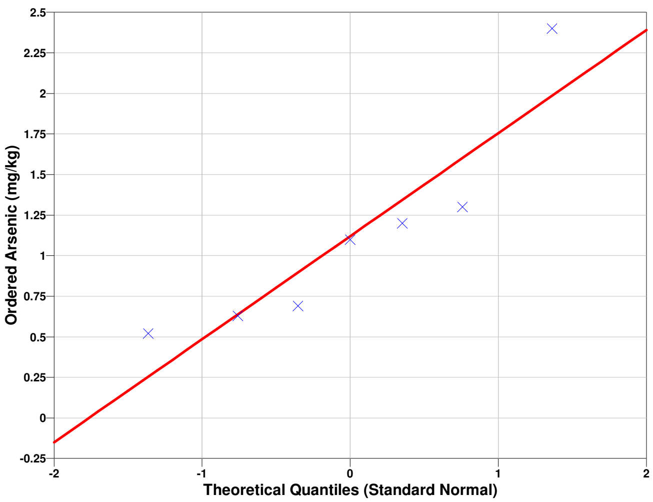
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Arsenic

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST

Shapiro-Wilk Test Statistic	0.8495
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	1.591
95% Non-Parametric (Chebyshev) UCL	2.175

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (1.591) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
3.0163	1.9432	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Data Analysis for Barium
The following data points were entered by the user for analysis.

Barium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	17.9	21.6	22.3	24.3	45.5	45.7	209			

SUMMARY STATISTICS for Barium	
n	7
Min	17.9
Max	209

Range				191.1				
Mean				55.186				
Median				24.3				
Variance				4732.7				
StdDev				68.795				
Std Error				26.002				
Skewness				2.4958				
Interquartile Range				24.1				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
17.9	17.9	17.9	21.6	24.3	45.7	209	209	209

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Barium	
Dixon Test Statistic	0.019362
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 17.9 is not an outlier at the 10% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6209
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic is less than the 10% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 17.9, do not appear to follow a normal distribution at the 10% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

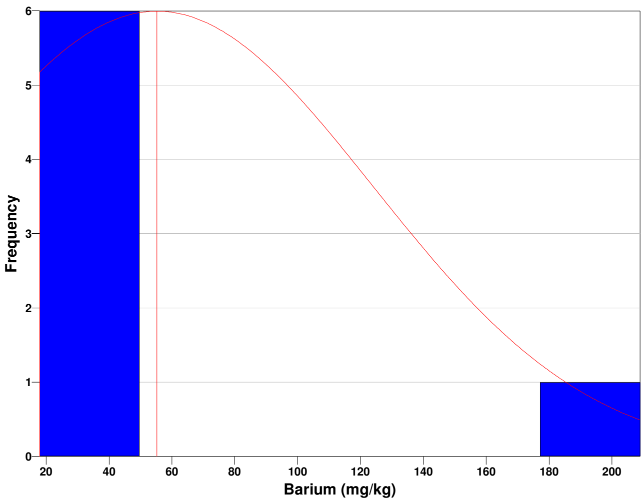
Data Plots for Barium
Graphical displays of the data are shown below.

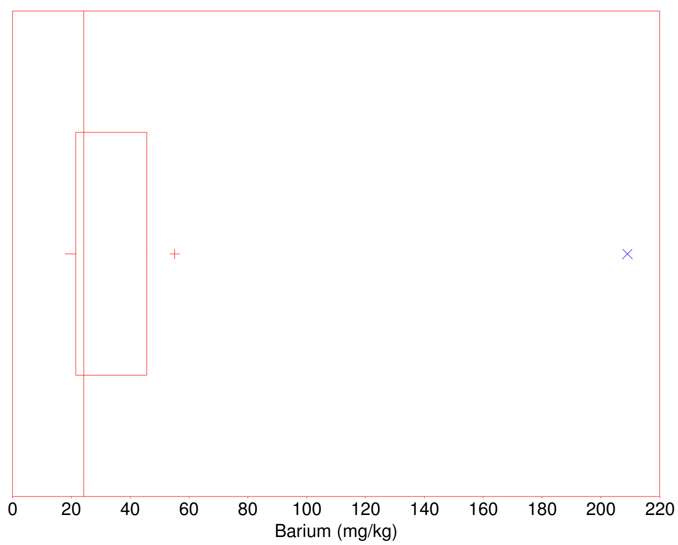
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

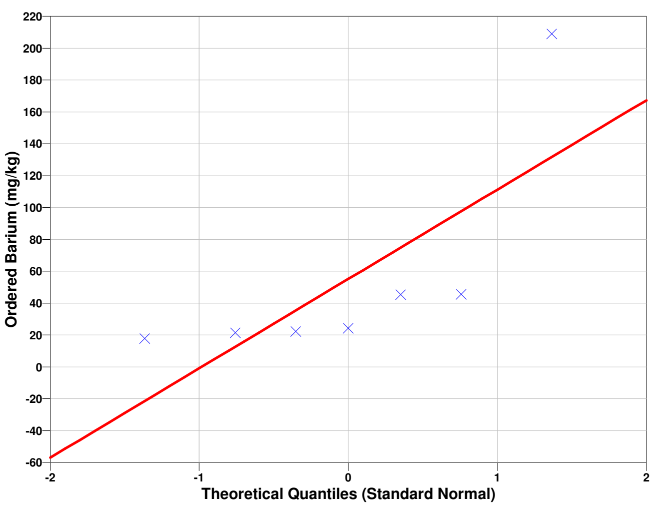
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box,

called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Barium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST

Shapiro-Wilk Test Statistic	0.5921
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	105.7
95% Non-Parametric (Chebyshev) UCL	168.5

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (168.5) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-299.41	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Data Analysis for Beryllium
The following data points were entered by the user for analysis.

Beryllium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

0	0.098	0.13	0.14	0.18	0.19	0.19	0.2			

SUMMARY STATISTICS for Beryllium								
n	7							
Min	0.098							
Max	0.2							
Range	0.102							
Mean	0.16114							
Median	0.18							
Variance	0.0014891							
StdDev	0.038589							
Std Error	0.014585							
Skewness	-0.72264							
Interquartile Range	0.06							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.098	0.098	0.098	0.13	0.18	0.19	0.2	0.2	0.2

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Beryllium	
Dixon Test Statistic	0.31373
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.098 is not an outlier at the 10% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8383
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.098, do appear to follow a normal distribution at the 10% level of significance.

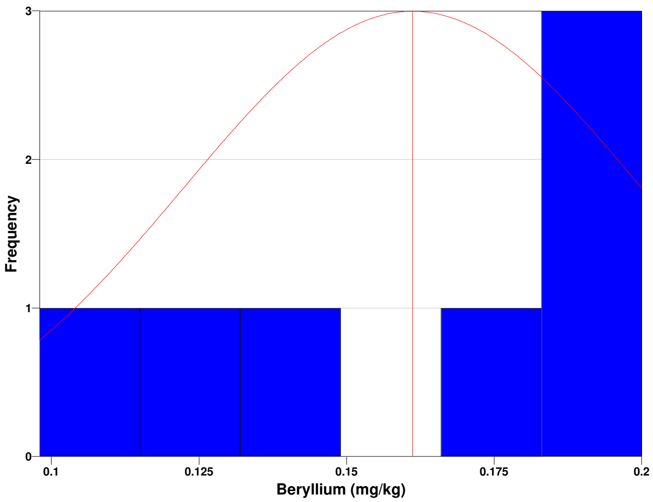
Data Plots for Beryllium
Graphical displays of the data are shown below.

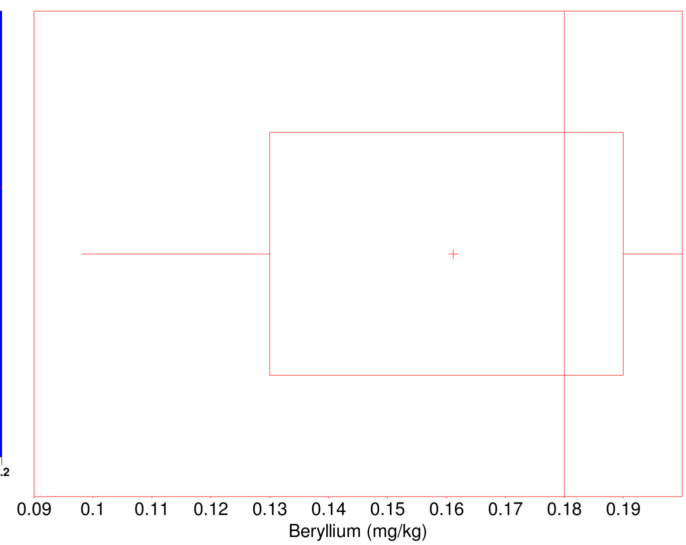
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

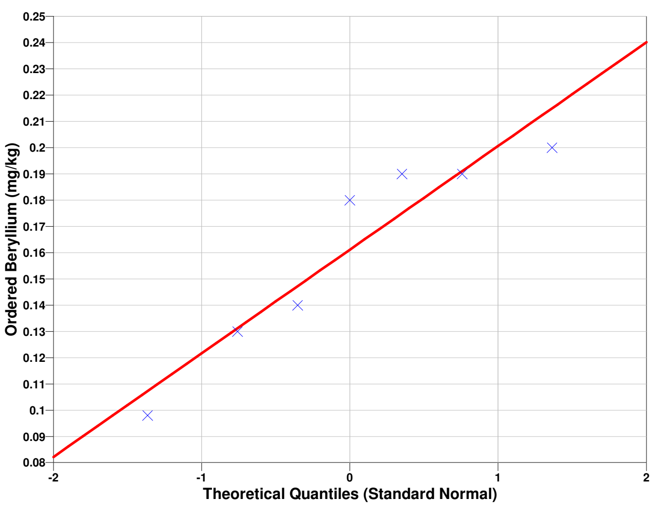
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Beryllium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8819
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.1895
95% Non-Parametric (Chebyshev) UCL	0.2247

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0.1895) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-2564.4	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Chromium
The following data points were entered by the user for analysis.

Chromium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	2.2	2.7	3.2	3.4	3.6	3.9	4			

SUMMARY STATISTICS for Chromium

n	7
Min	2.2
Max	4
Range	1.8
Mean	3.2857
Median	3.4
Variance	0.42143
StdDev	0.64918
Std Error	0.24537
Skewness	-0.72718
Interquartile Range	1.2

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
2.2	2.2	2.2	2.7	3.4	3.9	4	4	4

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Chromium	
Dixon Test Statistic	0.27778
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 2.2 is not an outlier at the 10% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9558
Shapiro-Wilk 10% Critical Value	0.826

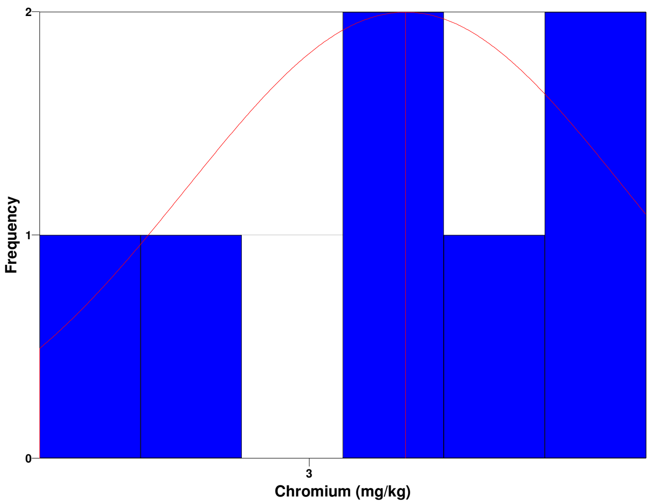
The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 2.2, do appear to follow a normal distribution at the 10% level of significance.

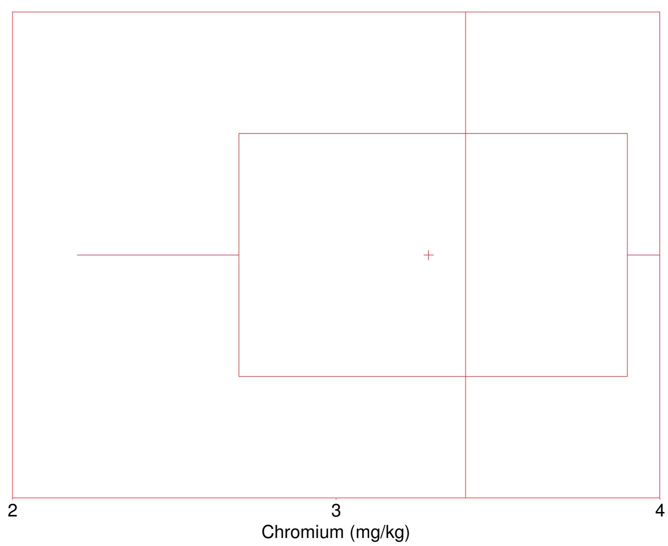
Data Plots for Chromium
Graphical displays of the data are shown below.

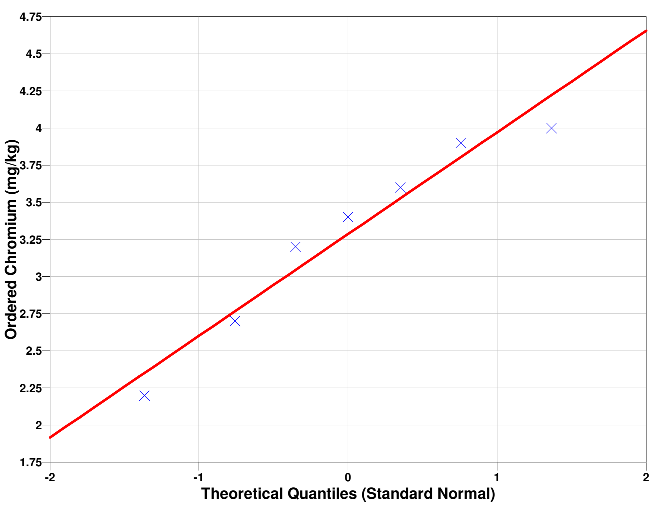
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Chromium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST

Shapiro-Wilk Test Statistic	0.94
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	3.763
95% Non-Parametric (Chebyshev) UCL	4.355

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (3.763) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-845.23	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Cobalt
The following data points were entered by the user for analysis.

Cobalt (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.6	0.63	0.8	0.81	0.88	1.1	1.1			

SUMMARY STATISTICS for Cobalt	
n	7
Min	0.6
Max	1.1

Range				0.5				
Mean				0.84571				
Median				0.81				
Variance				0.040129				
StdDev				0.20032				
Std Error				0.075714				
Skewness				0.22963				
Interquartile Range				0.47				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.6	0.6	0.6	0.63	0.81	1.1	1.1	1.1	1.1

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Cobalt	
Dixon Test Statistic	0.06
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.6 is not an outlier at the 10% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9047
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.6, do appear to follow a normal distribution at the 10% level of significance.

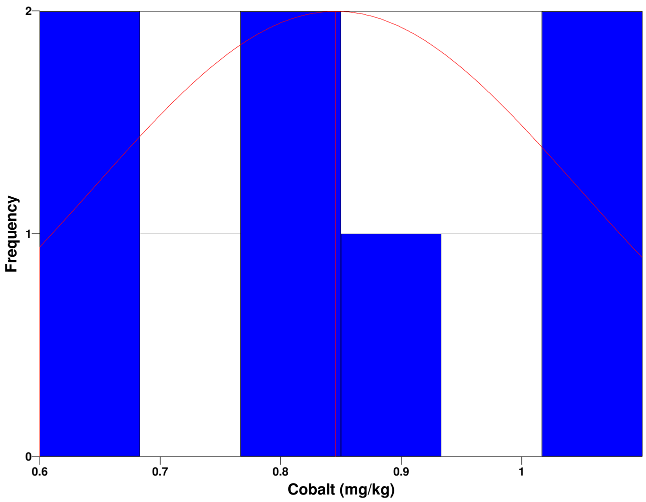
Data Plots for Cobalt
Graphical displays of the data are shown below.

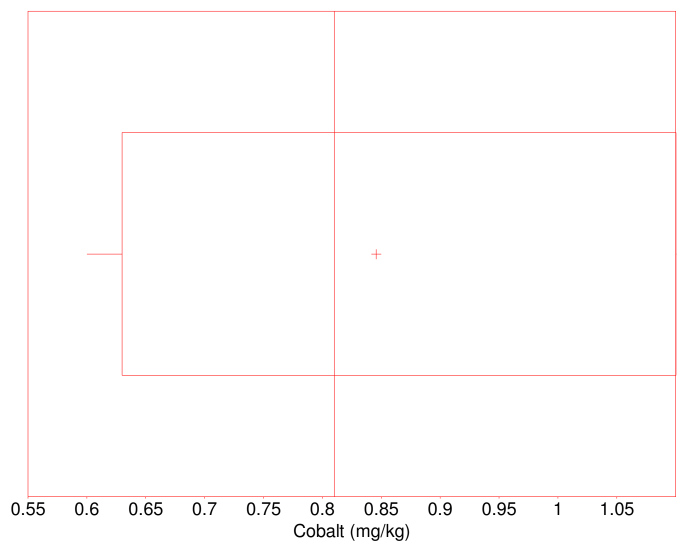
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

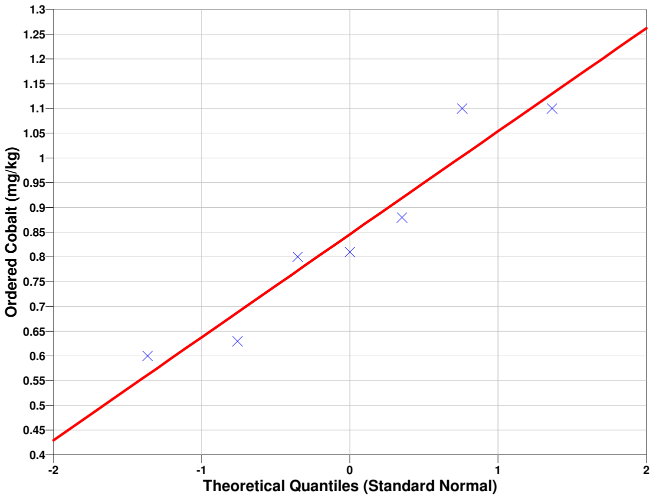
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends

to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Cobalt
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8993
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.9928
95% Non-Parametric (Chebyshev) UCL	1.176

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0.9928) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-11914	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Copper
The following data points were entered by the user for analysis.

Copper (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1.3	1.9	2	2	2.3	2.6	5			

SUMMARY STATISTICS for Copper	
n	7
Min	1.3
Max	5
Range	3.7
Mean	2.4429

Median				2				
Variance				1.4295				
StdDev				1.1956				
Std Error				0.4519				
Skewness				2.0335				
Interquartile Range				0.7				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
1.3	1.3	1.3	1.9	2	2.6	5	5	5

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Copper	
Dixon Test Statistic	0.16216
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 1.3 is not an outlier at the 10% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6789
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic is less than the 10% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 1.3, do not appear to follow a normal distribution at the 10% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

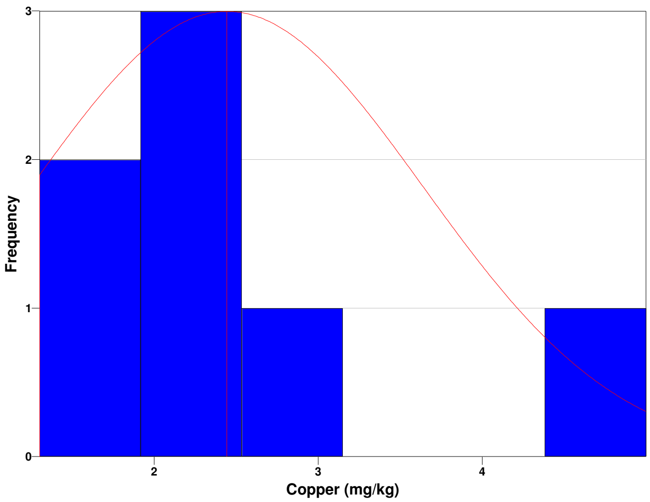
Data Plots for Copper
Graphical displays of the data are shown below.

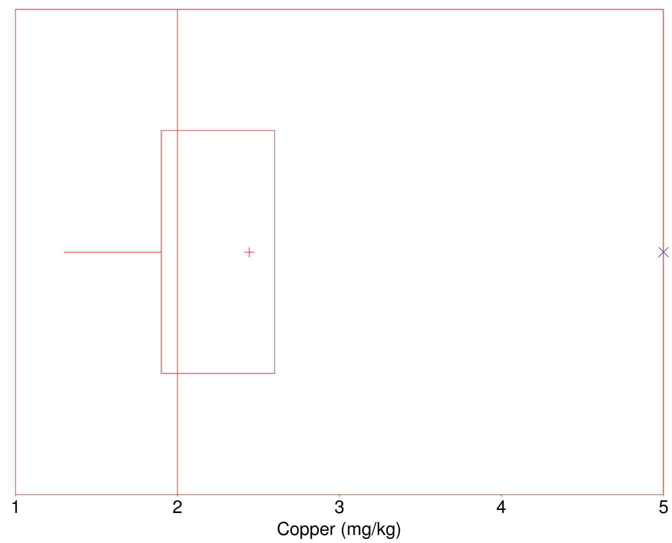
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

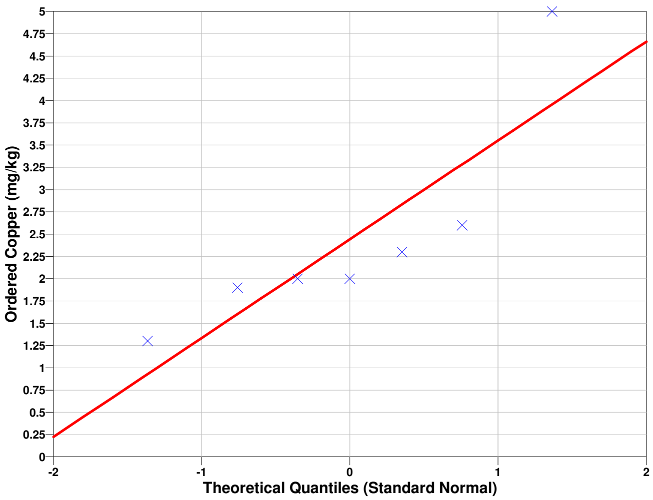
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends

to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Copper

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7643
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	3.321
95% Non-Parametric (Chebyshev) UCL	4.413

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (4.413) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1206.3	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Data Analysis for Lead
The following data points were entered by the user for analysis.

Lead (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	2.4	2.5	2.7	2.8	3.1	3.1	4.3			

SUMMARY STATISTICS for Lead

n	7
Min	2.4
Max	4.3
Range	1.9
Mean	2.9857
Median	2.8
Variance	0.4081
StdDev	0.63882
Std Error	0.24145
Skewness	1.7256
Interquartile Range	0.6

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
2.4	2.4	2.4	2.5	2.8	3.1	4.3	4.3	4.3

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Lead	
Dixon Test Statistic	0.052632
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 2.4 is not an outlier at the 10% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8201
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic is less than the 10% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 2.4, do not appear to follow a normal distribution at the 10% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

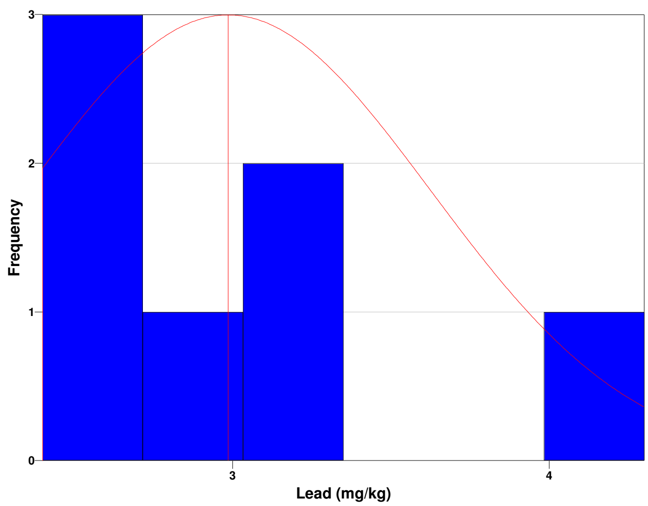
Data Plots for Lead
Graphical displays of the data are shown below.

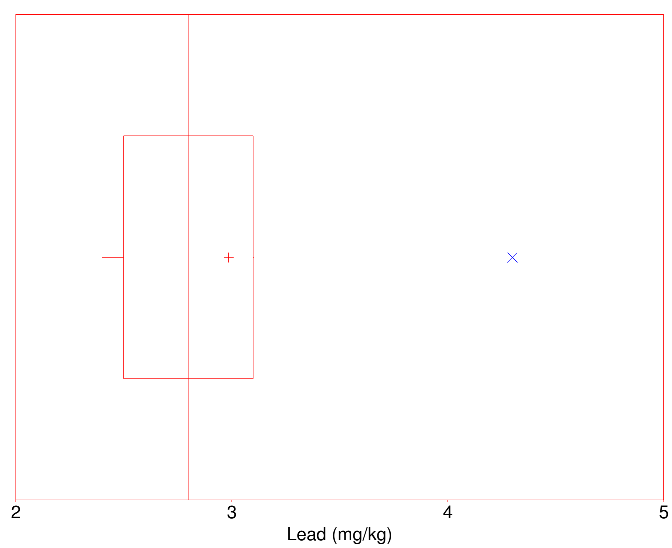
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The

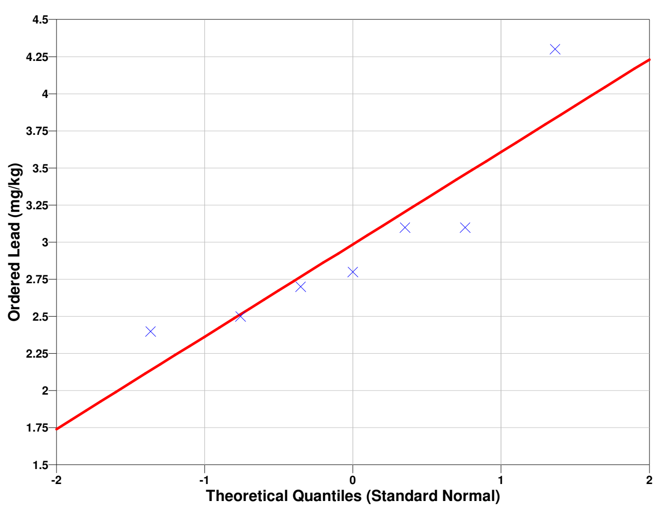
sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Lead

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution.

The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.826
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	3.455
95% Non-Parametric (Chebyshev) UCL	4.038

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (3.455) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1644.3	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Manganese
The following data points were entered by the user for analysis.

Manganese (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	26.9	41.4	42.2	76.3	95.5	113	114			

SUMMARY STATISTICS for Manganese

n	7							
Min	26.9							
Max	114							
Range	87.1							
Mean	72.757							
Median	76.3							
Variance	1311.7							
StdDev	36.217							
Std Error	13.689							
Skewness	-0.042551							
Interquartile Range	71.6							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
26.9	26.9	26.9	41.4	76.3	113	114	114	114

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Manganese	
Dixon Test Statistic	0.16648
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 26.9 is not an outlier at the 10% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8596
Shapiro-Wilk 10% Critical Value	0.826

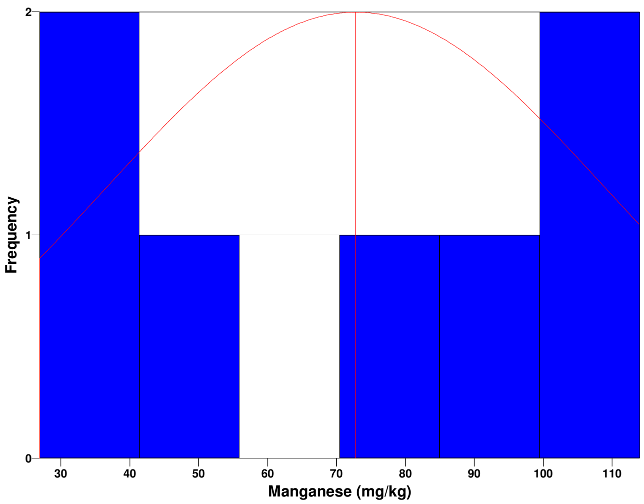
The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 26.9, do appear to follow a normal distribution at the 10% level of significance.

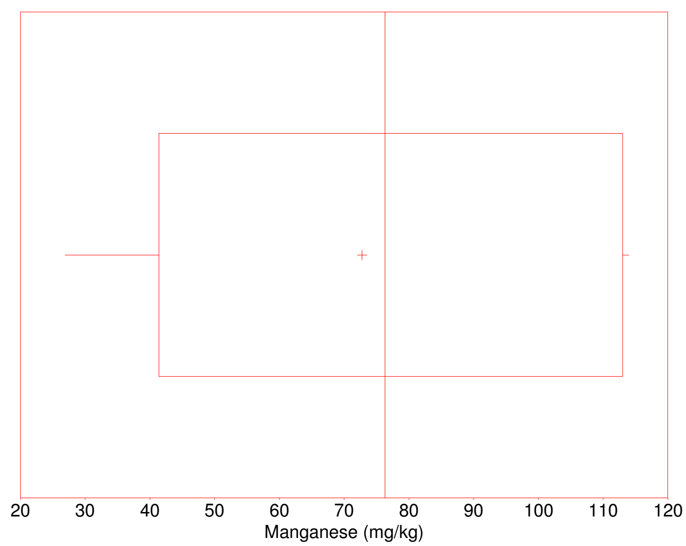
Data Plots for Manganese
Graphical displays of the data are shown below.

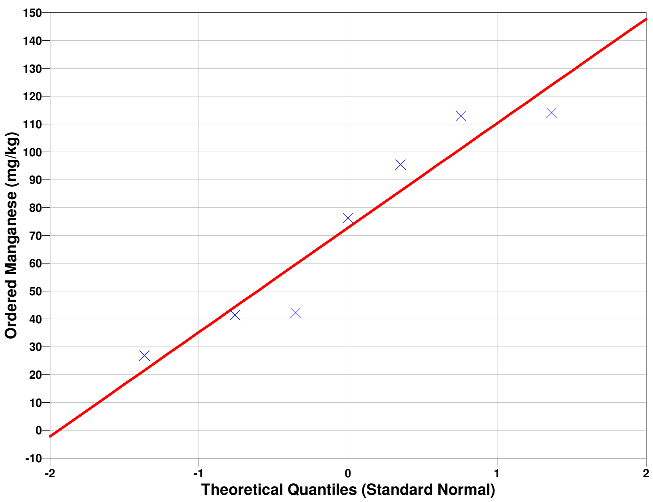
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Manganese

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST

Shapiro-Wilk Test Statistic	0.885
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	99.36
95% Non-Parametric (Chebyshev) UCL	132.4

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (99.36) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-231.32	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Mercury
The following data points were entered by the user for analysis.

Mercury (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.002	0.0023	0.0059	0.0065	0.012	0.033	0.034			

SUMMARY STATISTICS for Mercury	
n	7
Min	0.002
Max	0.034

Range				0.032				
Mean				0.013671				
Median				0.0065				
Variance				0.0001945				
StdDev				0.013946				
Std Error				0.0052712				
Skewness				1.008				
Interquartile Range				0.0307				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.002	0.002	0.002	0.0023	0.0065	0.033	0.034	0.034	0.034

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Mercury	
Dixon Test Statistic	0.009375
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.002 is not an outlier at the 10% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8042
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic is less than the 10% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.002, do not appear to follow a normal distribution at the 10% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

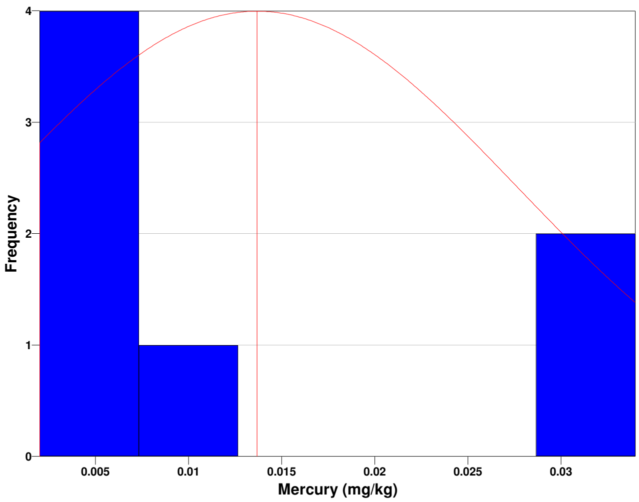
Data Plots for Mercury
Graphical displays of the data are shown below.

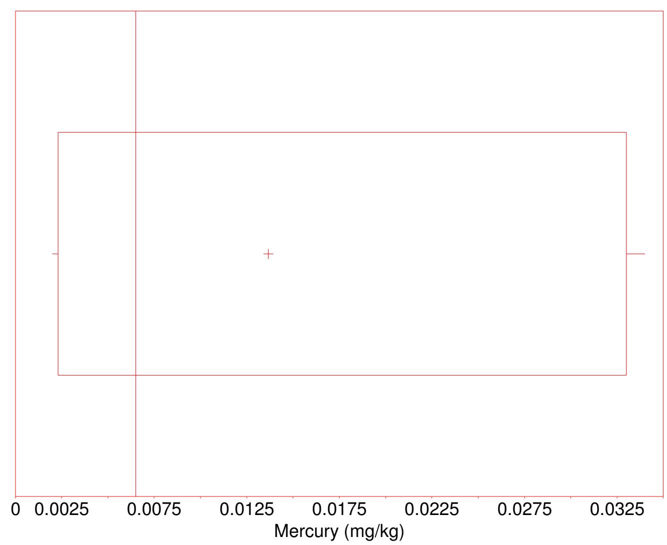
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

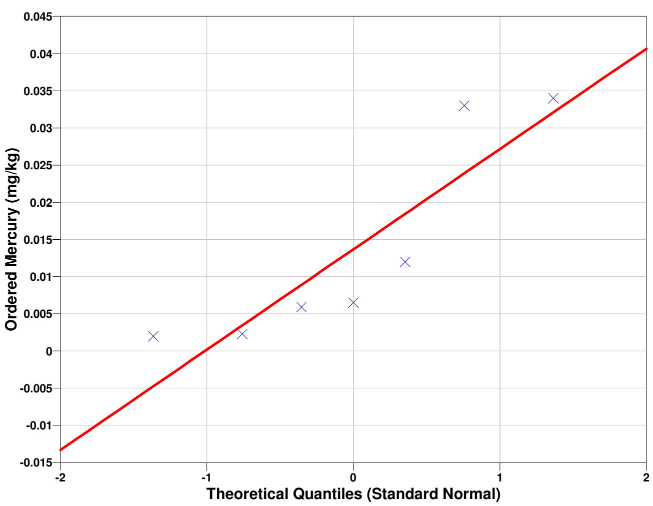
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box,

called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Mercury

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST

Shapiro-Wilk Test Statistic	0.7766
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.02391
95% Non-Parametric (Chebyshev) UCL	0.03665

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.03665) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-393.37	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Data Analysis for Nickel
The following data points were entered by the user for analysis.

Nickel (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

0	1.2	1.2	1.4	1.6	1.8	1.9	2.3			

SUMMARY STATISTICS for Nickel								
n	7							
Min	1.2							
Max	2.3							
Range	1.1							
Mean	1.6286							
Median	1.6							
Variance	0.16238							
StdDev	0.40297							
Std Error	0.15231							
Skewness	0.56458							
Interquartile Range	0.7							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
1.2	1.2	1.2	1.2	1.6	1.9	2.3	2.3	2.3

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Nickel	
Dixon Test Statistic	0
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 1.2 is not an outlier at the 10% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.985
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 1.2, do appear to follow a normal distribution at the 10% level of significance.

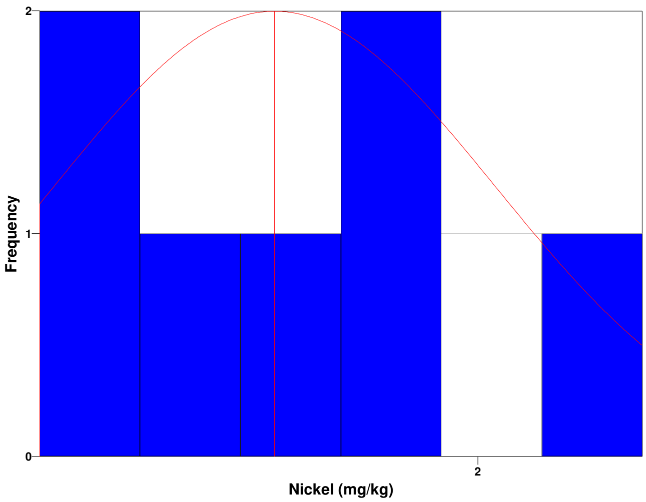
Data Plots for Nickel
Graphical displays of the data are shown below.

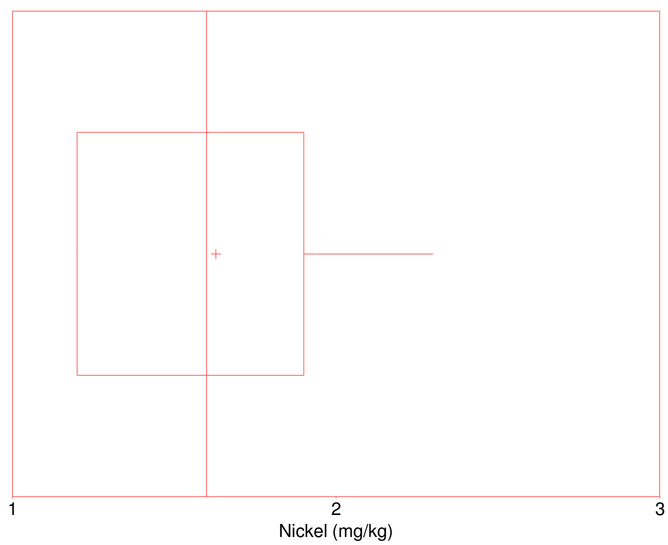
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

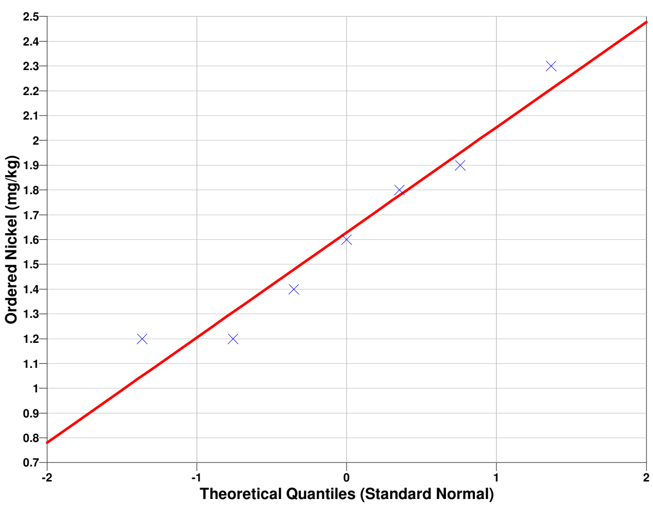
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Nickel
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9338
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	1.925
95% Non-Parametric (Chebyshev) UCL	2.292

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (1.925) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-5452.7	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Toluene
The following data points were entered by the user for analysis.

Toluene (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00075	0.00075	0.00075	0.0016	0.0017	0.0017	0.0018			

SUMMARY STATISTICS for Toluene

n					7			
Min					0.00075			
Max					0.0018			
Range					0.00105			
Mean					0.0012929			
Median					0.0016			
Variance					2.6119e-007			
StdDev					0.00051107			
Std Error					0.00019317			
Skewness					-0.32432			
Interquartile Range					0.00095			
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00075	0.00075	0.00075	0.00075	0.0016	0.0017	0.0018	0.0018	0.0018

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Toluene	
Dixon Test Statistic	0
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.00075 is not an outlier at the 10% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7386
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic is less than the 10% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.00075, do not appear to follow a normal distribution at the 10% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

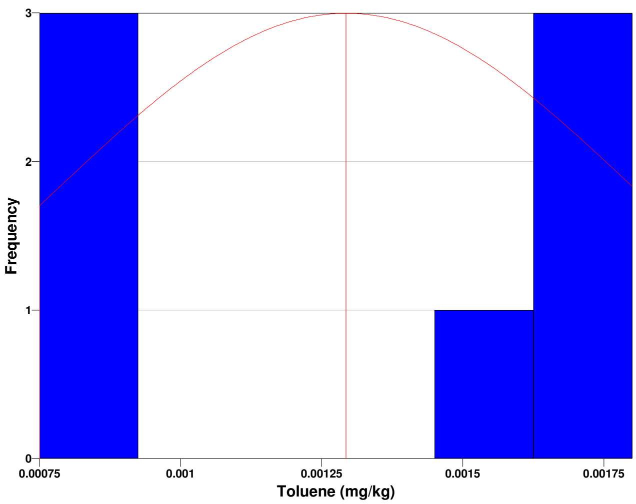
Data Plots for Toluene
Graphical displays of the data are shown below.

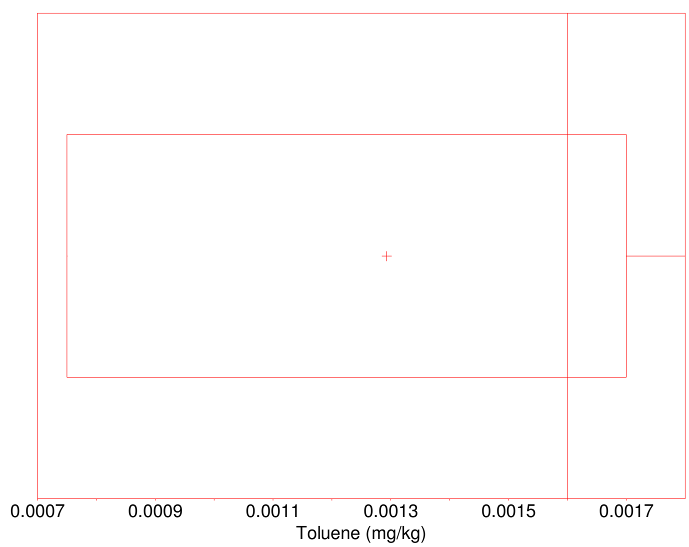
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each

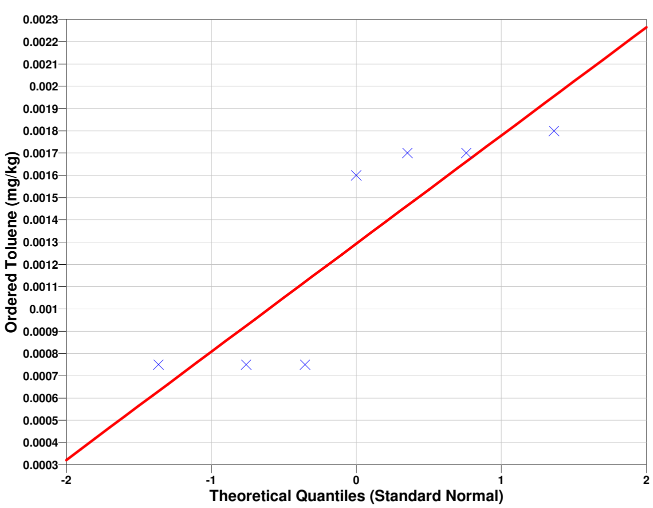
bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Toluene
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7381
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.001668
95% Non-Parametric (Chebyshev) UCL	0.002135

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.002135) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-2.698e+006	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Data Analysis for Vanadium
The following data points were entered by the user for analysis.

Vanadium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	4.4	4.5	4.6	5.1	5.3	5.5	7.9			

SUMMARY STATISTICS for Vanadium								
n	7							
Min	4.4							
Max	7.9							
Range	3.5							
Mean	5.3286							
Median	5.1							
Variance	1.4624							
StdDev	1.2093							
Std Error	0.45707							
Skewness	2.0108							
Interquartile Range	1							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
4.4	4.4	4.4	4.5	5.1	5.5	7.9	7.9	7.9

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Vanadium	
Dixon Test Statistic	0.028571
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 4.4 is not an outlier at the 10% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7768
Shapiro-Wilk 10% Critical Value	0.826

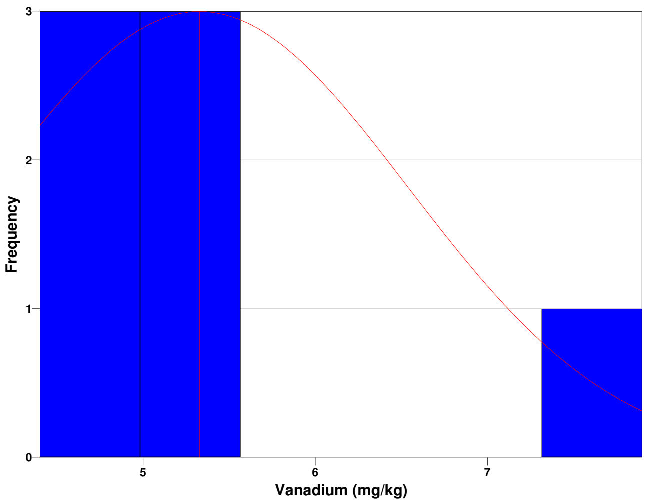
The calculated Shapiro-Wilk test statistic is less than the 10% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 4.4, do not appear to follow a normal distribution at the 10% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

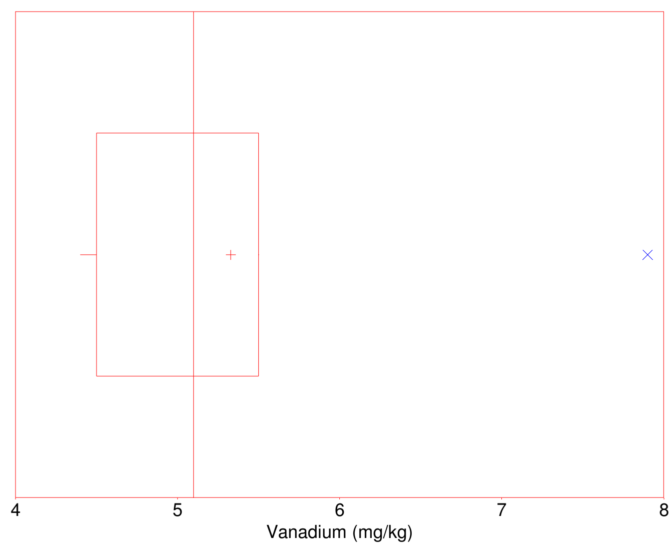
Data Plots for Vanadium
Graphical displays of the data are shown below.

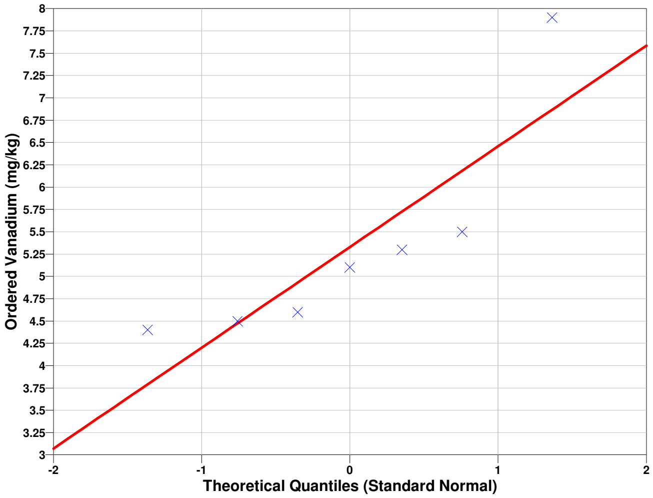
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Vanadium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7602
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	6.217
95% Non-Parametric (Chebyshev) UCL	7.321

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (7.321) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-625.04	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Data Analysis for Zinc
The following data points were entered by the user for analysis.

Zinc (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	8.9	10.2	11.9	13.7	17.5	18.2	35.8			

SUMMARY STATISTICS for Zinc								
n	7							
Min	8.9							
Max	35.8							
Range	26.9							
Mean	16.6							
Median	13.7							
Variance	83.793							
StdDev	9.1539							
Std Error	3.4598							
Skewness	1.897							
Interquartile Range	8							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
8.9	8.9	8.9	10.2	13.7	18.2	35.8	35.8	35.8

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible

explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Zinc	
Dixon Test Statistic	0.048327
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 8.9 is not an outlier at the 10% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7948
Shapiro-Wilk 10% Critical Value	0.826

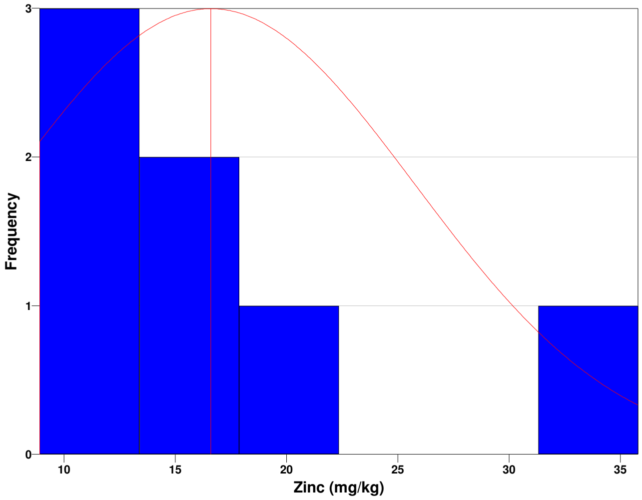
The calculated Shapiro-Wilk test statistic is less than the 10% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 8.9, do not appear to follow a normal distribution at the 10% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

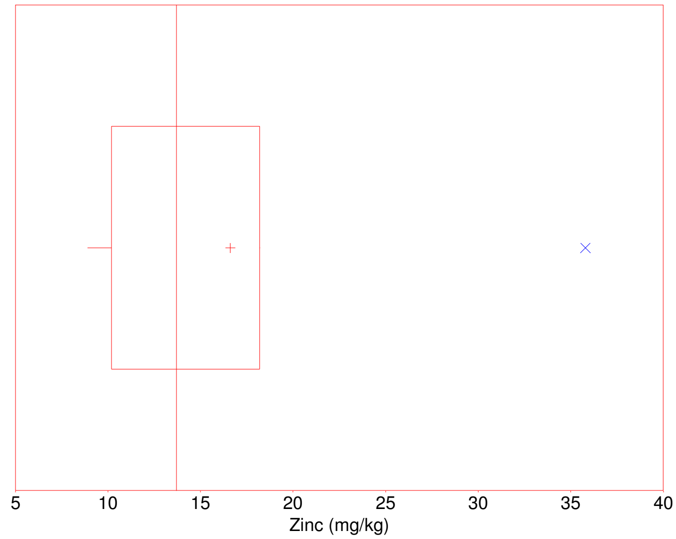
Data Plots for Zinc
Graphical displays of the data are shown below.

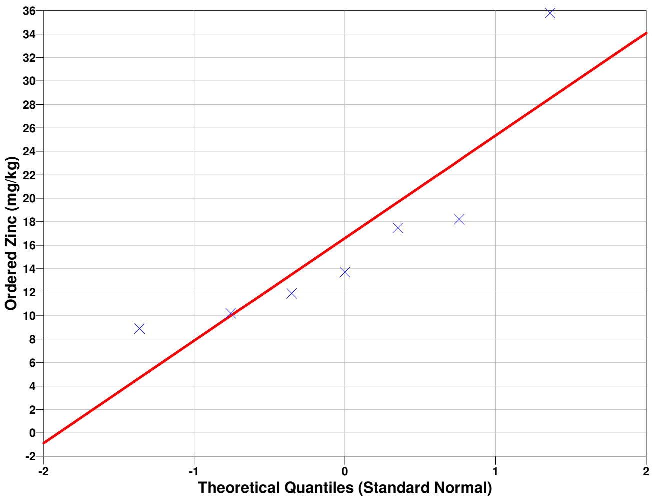
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Zinc
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7937
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	23.32

95% Non-Parametric (Chebyshev) UCL	31.68

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (31.68) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (0.389624),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-2862.8	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

This report was automatically produced* by Visual Sample Plan (VSP) software version 5.3.1.
Software and documentation available at http://dqo.pnl.gov/vsp

* - The report contents may have been modified or reformatted by end-user of software.

Appendix C

VSP Reports of Calculated Minimum Sample Quantity
Report 17
Area of Concern – 3
Minimum Sample Quantity Calculation for Subsurface Soil using Ecological Benchmarks and Delta Method 1

Random sampling locations for comparing a mean with a fixed threshold (parametric)

Summary
This report summarizes the sampling design, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design for Vanadium, the driving analyte (the analyte which required the largest number of samples). A figure that shows sampling locations in the field and a table that lists sampling location coordinates are also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean to a fixed threshold
Type of Sampling Design	Parametric
Sample Placement (Location) in the Field	Simple random sampling
Working (Null) Hypothesis	The mean value at the site exceeds the threshold
Formula for calculating number of sampling locations	Student's t-test
Calculated total number of samples	3
Number of samples on map [a]	7
Number of selected sample areas [b]	1
Specified sampling area [c]	602117.04 m^2
Total cost of sampling [d]	$2,500.00

[a] This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[d] Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.

Area: Area 1					
X Coord	**Y Coord**	**Label**	**Value**	**Type**	**Historical**
680077.3540	3083115.5330	J-50S		Manual	T
680141.8730	3083080.8800	J-52S		Manual	T
680170.5600	3083064.6740	J-53S		Manual	T

679924.8150	3082872.3490	J-47S		Manual	T
679994.9690	3082983.5100	J-48S		Manual	T
680057.6580	3083072.0750	J-49S		Manual	T
679827.1150	3082729.7460	J-51S		Manual	T

Primary Sampling Objective
The primary purpose of sampling at this site is to compare a mean value of a site with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the mean value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the mean value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative hypothesis, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach
A parametric random sampling approach was used to determine the number of samples and to specify sampling locations. A parametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that parametric assumptions are reasonable. These assumptions will be examined in post-sampling data analysis.

Both parametric and non-parametric approaches rely on assumptions about the population. However, non-parametric approaches typically require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than the number of samples required by non-parametric approaches.

Locating the sample points randomly provides data that are separated by many distances, whereas systematic samples are all equidistant apart. Therefore, random sampling provides more information about the spatial structure of the potential contamination than systematic sampling does. As with systematic sampling, random sampling also provides information regarding the mean value, but there is the possibility that areas of the site will not be represented with the same frequency as if uniform grid sampling were performed.

Number of Total Samples: Calculation Equation and Inputs
The equation used to calculate the number of samples is based on a Student's t-test. For this site, the null hypothesis is rejected in favor of the alternative hypothesis if the sample mean is sufficiently smaller than the threshold. The number of samples to collect is calculated so that 1) there will be a high probability ($1-\beta$) of rejecting the null hypothesis if the alternative hypothesis is true and 2) a low probability (α) of rejecting the null hypothesis if the null hypothesis is true.

The formula used to calculate the number of samples is:

$$n = \frac{S^2}{\Delta^2}\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2 + 0.5Z_{1-\alpha}^2$$

where
n is the number of samples,
S is the estimated standard deviation of the measured values including analytical error,
Δ is the width of the gray region,
α is the acceptable probability of incorrectly concluding the site mean is less than the threshold,
β is the acceptable probability of incorrectly concluding the site mean exceeds the threshold,
$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is $1-\alpha$,
$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is $1-\beta$.

The values of these inputs that result in the calculated number of sampling locations are:

Analyte	n	Parameter					
		S	**Δ**	**α**	**β**	$Z_{1-\alpha}$ [a]	$Z_{1-\beta}$ [b]
New Location	2	0.1 mg/kg	10 mg/kg	0.05	0.1	1.64485	1.28155
Arsenic	2	0.640651 mg/kg	16.88 mg/kg	0.05	0.1	1.64485	1.28155
Barium	2	68.7947 mg/kg	274.814 mg/kg	0.05	0.1	1.64485	1.28155

Beryllium	2	0.0385894 mg/kg	9.83886 mg/kg	0.05	0.1	1.64485	1.28155
Chromium	2	0.649175 mg/kg	2.88571 mg/kg	0.05	0.1	1.64485	1.28155
Cobalt	2	0.200321 mg/kg	12.1543 mg/kg	0.05	0.1	1.64485	1.28155
Copper	2	1.19563 mg/kg	58.5571 mg/kg	0.05	0.1	1.64485	1.28155
Lead	2	0.638823 mg/kg	117.014 mg/kg	0.05	0.1	1.64485	1.28155
Manganese	2	36.2173 mg/kg	427.243 mg/kg	0.05	0.1	1.64485	1.28155
Mercury	2	0.0139463 mg/kg	0.0863286 mg/kg	0.05	0.1	1.64485	1.28155
Nickel	2	0.0139463 mg/kg	28.3714 mg/kg	0.05	0.1	1.64485	1.28155
Toluene	2	0.000511068 mg/kg	199.999 mg/kg	0.05	0.1	1.64485	1.28155
Vanadium	3	1.20929 mg/kg	3.32857 mg/kg	0.05	0.1	1.64485	1.28155
Zinc	2	9.15387 mg/kg	103.4 mg/kg	0.05	0.1	1.64485	1.28155

[a] This value is automatically calculated by VSP based upon the user defined value of α.
[b] This value is automatically calculated by VSP based upon the user defined value of β.

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000) for Vanadium, the driving analyte. It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true mean values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at 1-α on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at 1-α. If any of the inputs change, the number of samples that result in the correct curve changes.

Statistical Assumptions

The assumptions associated with the formulas for computing the number of samples are:

1. the sample mean is normally distributed (this happens if the data are roughly symmetric or the sample size is more than 30; for extremely skewed data sets, additional samples may be required for the sample mean to be normally distributed),
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected randomly.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the sample locations were selected using a random process.

Sensitivity Analysis

The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that μ > action level and alpha (%), probability of mistakenly concluding that μ < action level. The following table shows the results of this analysis.

Number of Samples							
AL=120		**α=5**		**α=10**		**α=15**	
		s=18.3077	**s=9.15387**	**s=18.3077**	**s=9.15387**	**s=18.3077**	**s=9.15387**
LBGR=90	**β=5**	90684	22673	71761	17941	60243	15061
	β=10	71761	17942	55049	13763	45024	11257
	β=15	60243	15062	45024	11257	36005	9002
LBGR=80	**β=5**	22673	5670	17941	4486	15061	3766
	β=10	17942	4487	13763	3442	11257	2815
	β=15	15062	3767	11257	2815	9002	2251
LBGR=70	**β=5**	10078	2521	7975	1995	6695	1674
	β=10	7975	1995	6118	1530	5004	1252
	β=15	6695	1675	5004	1252	4001	1001

s = Standard Deviation
LBGR = Lower Bound of Gray Region (% of Action Level)
β = Beta (%), Probability of mistakenly concluding that μ > action level
α = Alpha (%), Probability of mistakenly concluding that μ < action level
AL = Action Level (Threshold)

Cost of Sampling

The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that are based on the number of samples collected and measured. Based on the numbers of samples determined above, the estimated total cost of sampling and analysis at this site is $2,500.00, which averages out to a per sample cost of $833.33. The following table summarizes the inputs and resulting cost estimates.

COST INFORMATION			
Cost Details	**Per Analysis**	**Per Sample**	**3 Samples**
Field collection costs		$100.00	$300.00
Analytical costs	$400.00	$400.00	$1,200.00
Sum of Field & Analytical costs		**$500.00**	**$1,500.00**
Fixed planning and validation costs			$1,000.00
Total cost			**$2,500.00**

Data Analysis for Arsenic

The following data points were entered by the user for analysis.

Arsenic (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.52	0.63	0.69	1.1	1.2	1.3	2.4			

SUMMARY STATISTICS for Arsenic								
n	7							
Min	0.52							
Max	2.4							
Range	1.88							
Mean	1.12							
Median	1.1							
Variance	0.41043							
StdDev	0.64065							
Std Error	0.24214							
Skewness	1.5							
Interquartile Range	0.67							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.52	0.52	0.52	0.63	1.1	1.3	2.4	2.4	2.4

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Arsenic	
Dixon Test Statistic	0.058511
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.52 is not an outlier at the 10% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8507
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.52, do appear to follow a normal distribution at the 10% level of significance.

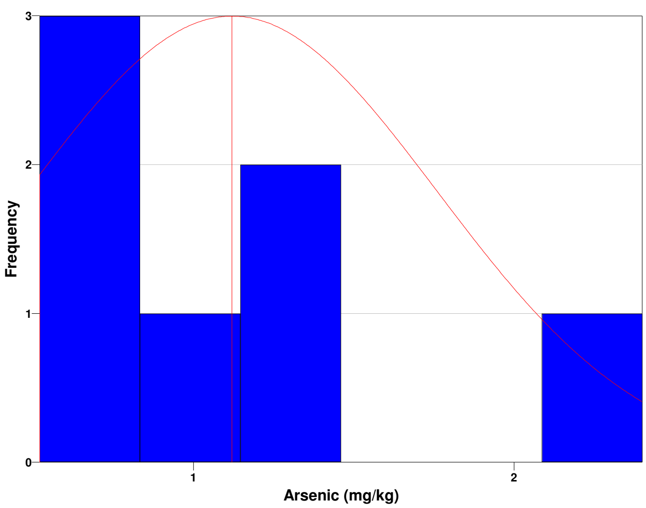
Data Plots for Arsenic

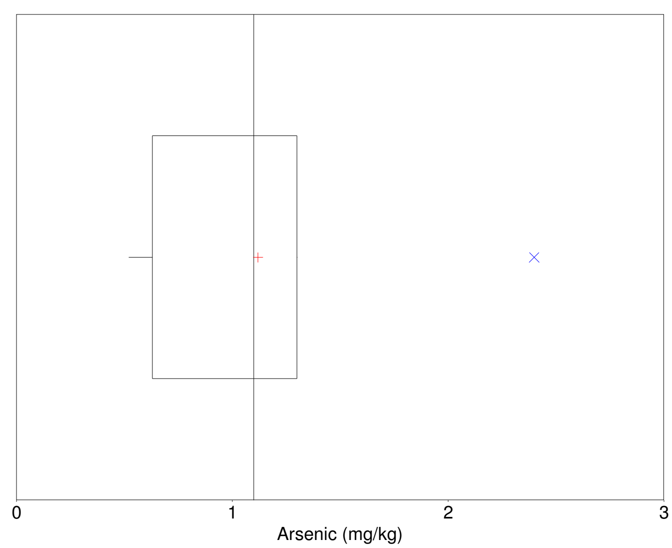
Graphical displays of the data are shown below.

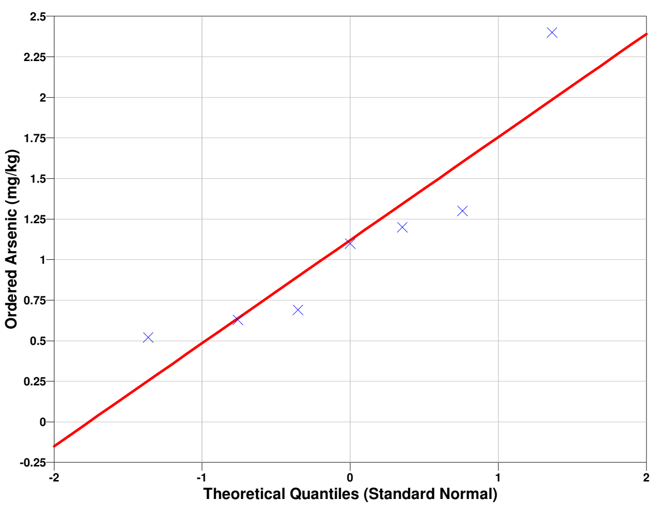
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Arsenic
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8495
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	1.591
95% Non-Parametric (Chebyshev) UCL	2.175

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (1.591) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-69.711	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Barium
The following data points were entered by the user for analysis.

Barium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

0	17.9	21.6	22.3	24.3	45.5	45.7	209			

SUMMARY STATISTICS for Barium								
n	7							
Min	17.9							
Max	209							
Range	191.1							
Mean	55.186							
Median	24.3							
Variance	4732.7							
StdDev	68.795							
Std Error	26.002							
Skewness	2.4958							
Interquartile Range	24.1							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
17.9	17.9	17.9	21.6	24.3	45.7	209	209	209

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Barium	
Dixon Test Statistic	0.019362
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 17.9 is not an outlier at the 10% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6209
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic is less than the 10% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 17.9, do not appear to follow a normal distribution at the 10% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

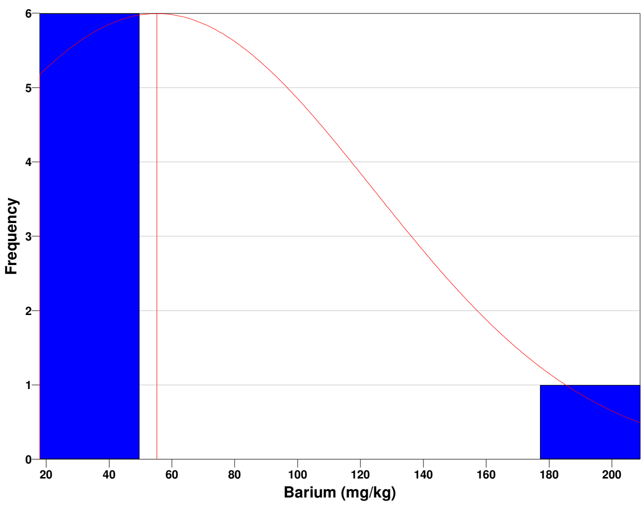
Data Plots for Barium

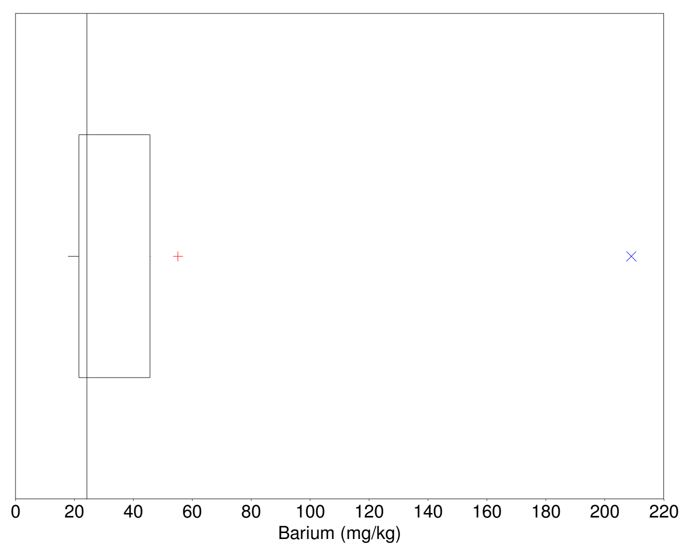
Graphical displays of the data are shown below.

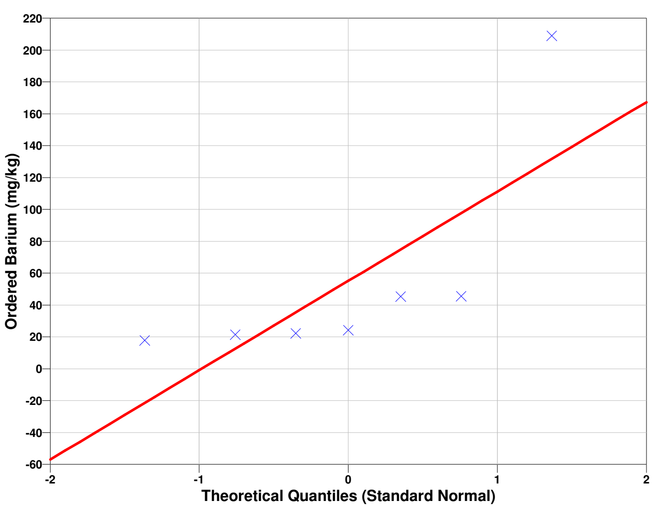
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Barium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5921
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	105.7
95% Non-Parametric (Chebyshev) UCL	168.5

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (168.5) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test

A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where

x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-10.569	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**

7	6	Reject

Data Analysis for Beryllium
The following data points were entered by the user for analysis.

Beryllium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.098	0.13	0.14	0.18	0.19	0.19	0.2			

SUMMARY STATISTICS for Beryllium								
n	7							
Min	0.098							
Max	0.2							
Range	0.102							
Mean	0.16114							
Median	0.18							
Variance	0.0014891							
StdDev	0.038589							
Std Error	0.014585							
Skewness	-0.72264							
Interquartile Range	0.06							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.098	0.098	0.098	0.13	0.18	0.19	0.2	0.2	0.2

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Beryllium	
Dixon Test Statistic	0.31373
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.098 is not an outlier at the 10% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8383
Shapiro-Wilk 10% Critical Value	0.826

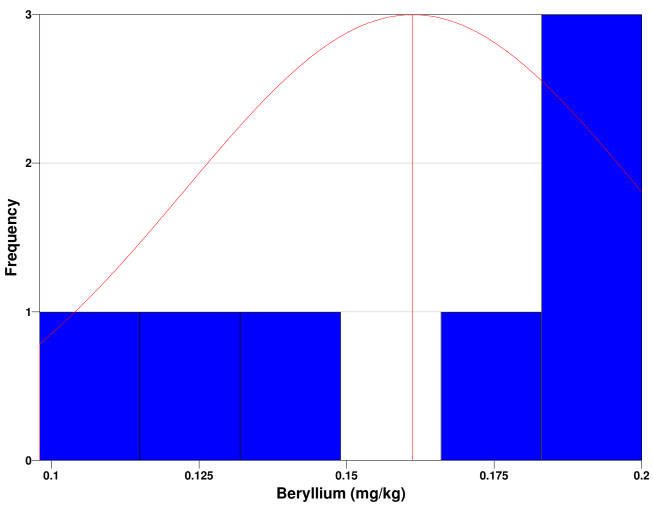
The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.098, do appear to follow a normal distribution at the 10% level of significance.

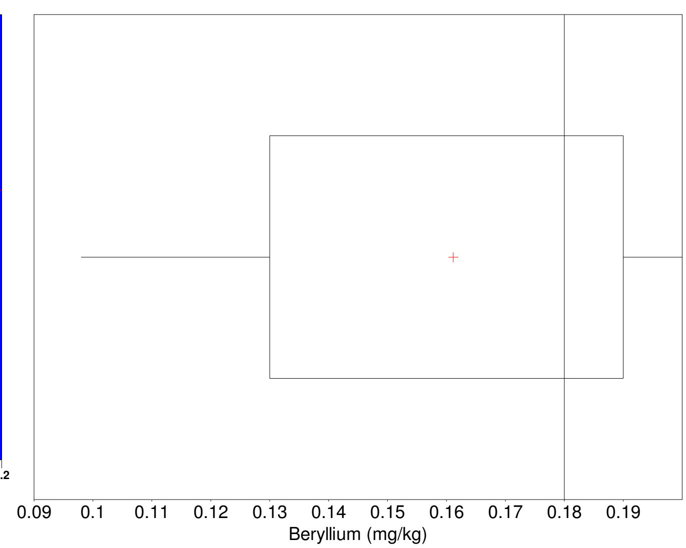
Data Plots for Beryllium
Graphical displays of the data are shown below.

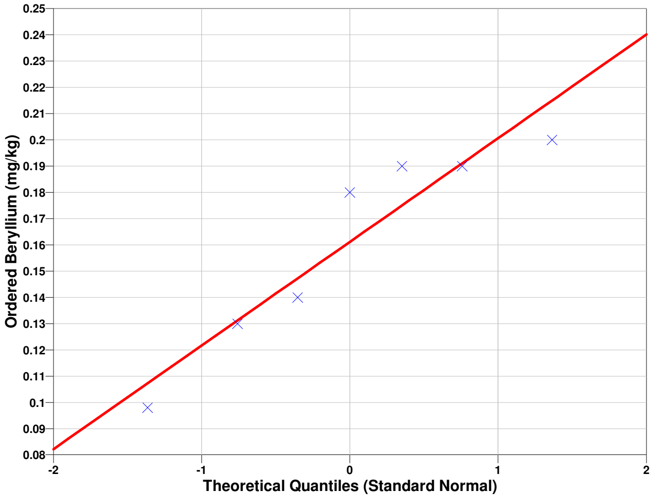
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Beryllium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8819
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.1895
95% Non-Parametric (Chebyshev) UCL	0.2247

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0.1895) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-674.57	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Chromium
The following data points were entered by the user for analysis.

Chromium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	2.2	2.7	3.2	3.4	3.6	3.9	4			

SUMMARY STATISTICS for Chromium								
n	7							
Min	2.2							
Max	4							
Range	1.8							
Mean	3.2857							
Median	3.4							
Variance	0.42143							
StdDev	0.64918							
Std Error	0.24537							
Skewness	-0.72718							
Interquartile Range	1.2							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
2.2	2.2	2.2	2.7	3.4	3.9	4	4	4

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Chromium	
Dixon Test Statistic	0.27778
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 2.2 is not an outlier at the 10% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9558
Shapiro-Wilk 10% Critical Value	0.826

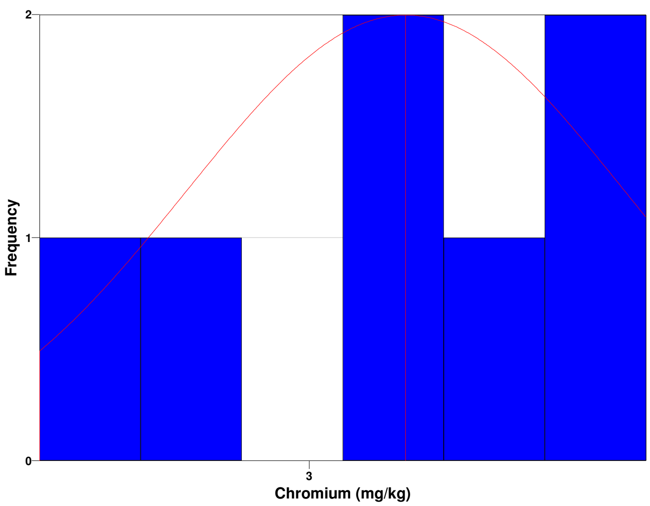
The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 2.2, do appear to follow a normal distribution at the 10% level of significance.

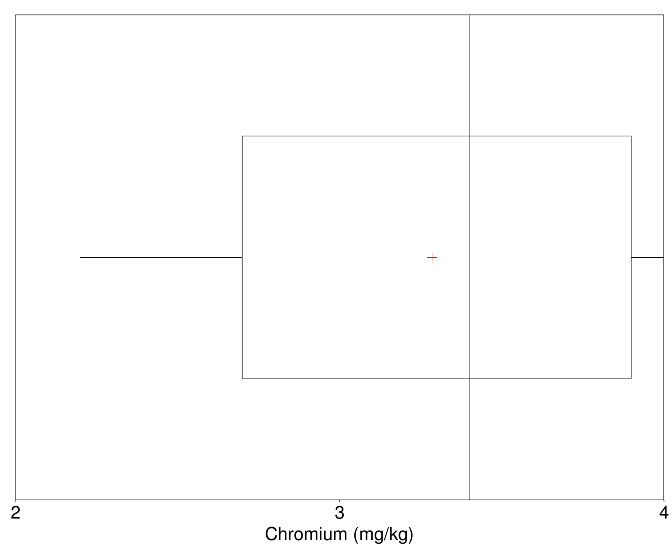
Data Plots for Chromium
Graphical displays of the data are shown below.

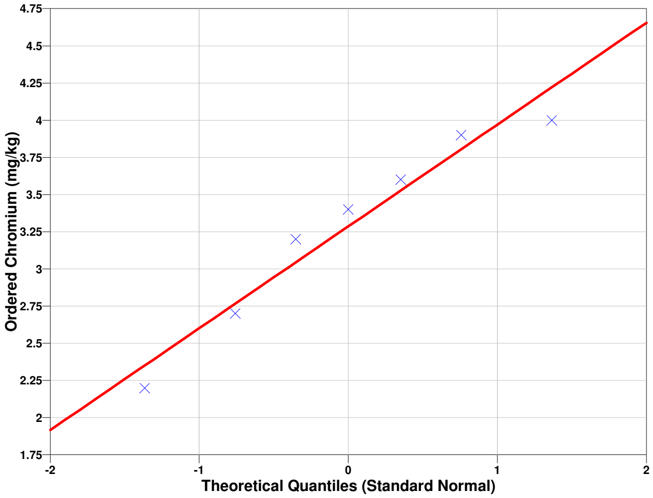
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Chromium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.94
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	3.763
95% Non-Parametric (Chebyshev) UCL	4.355

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (3.763) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test

A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where

x is the sample mean of the n=7 data,

AL is the action level or threshold (120),

SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
11.761	1.9432	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Data Analysis for Cobalt
The following data points were entered by the user for analysis.

Cobalt (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.6	0.63	0.8	0.81	0.88	1.1	1.1			

SUMMARY STATISTICS for Cobalt								
n	7							
Min	0.6							
Max	1.1							
Range	0.5							
Mean	0.84571							
Median	0.81							
Variance	0.040129							
StdDev	0.20032							
Std Error	0.075714							
Skewness	0.22963							
Interquartile Range	0.47							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.6	0.6	0.6	0.63	0.81	1.1	1.1	1.1	1.1

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Cobalt	
Dixon Test Statistic	0.06
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.6 is not an outlier at the 10% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9047
Shapiro-Wilk 10% Critical Value	0.826

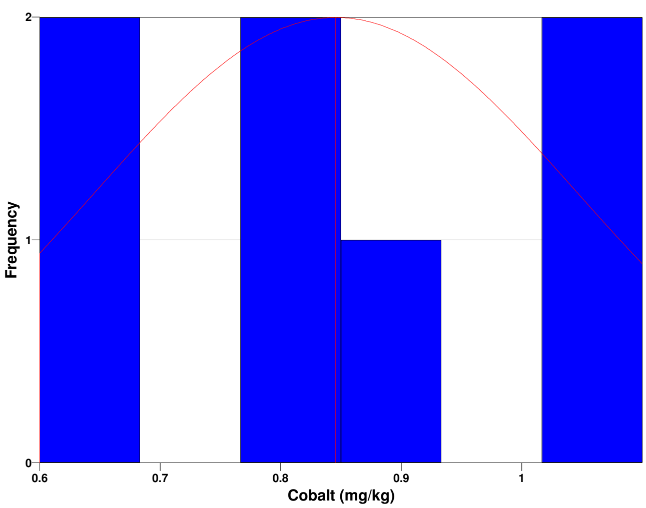
The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.6, do appear to follow a normal distribution at the 10% level of significance.

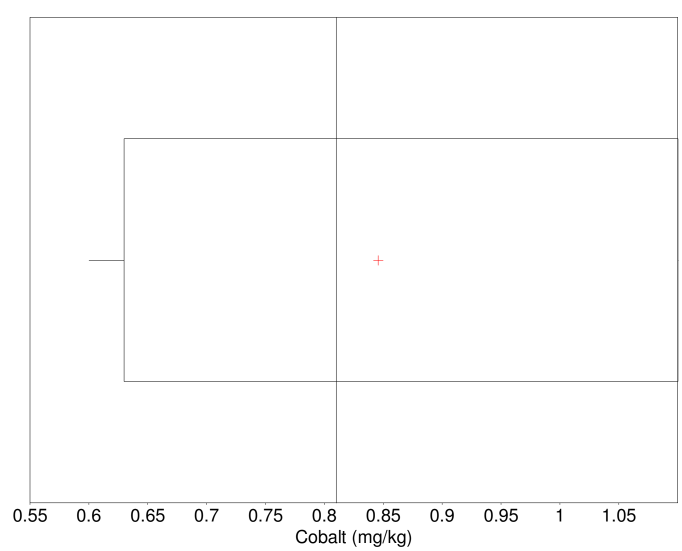
Data Plots for Cobalt
Graphical displays of the data are shown below.

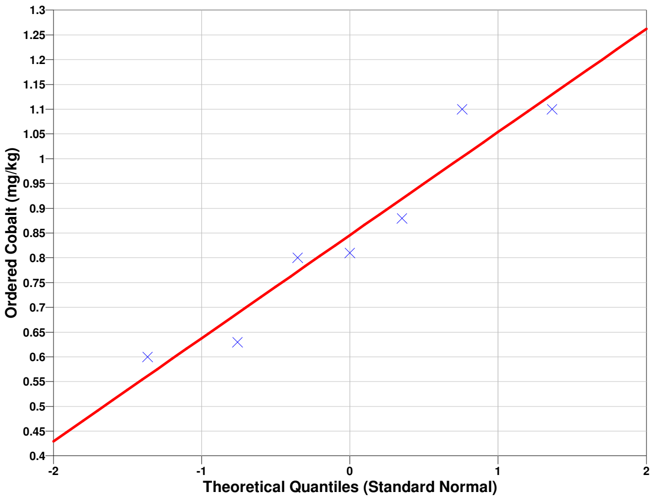
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Cobalt
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8993
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.9928
95% Non-Parametric (Chebyshev) UCL	1.176

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0.9928) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-160.53	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Copper
The following data points were entered by the user for analysis.

Copper (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1.3	1.9	2	2	2.3	2.6	5			

SUMMARY STATISTICS for Copper								
n	7							
Min	1.3							
Max	5							
Range	3.7							
Mean	2.4429							
Median	2							
Variance	1.4295							
StdDev	1.1956							
Std Error	0.4519							
Skewness	2.0335							
Interquartile Range	0.7							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
1.3	1.3	1.3	1.9	2	2.6	5	5	5

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Copper	
Dixon Test Statistic	0.16216
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 1.3 is not an outlier at the 10% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6789
Shapiro-Wilk 10% Critical Value	0.826

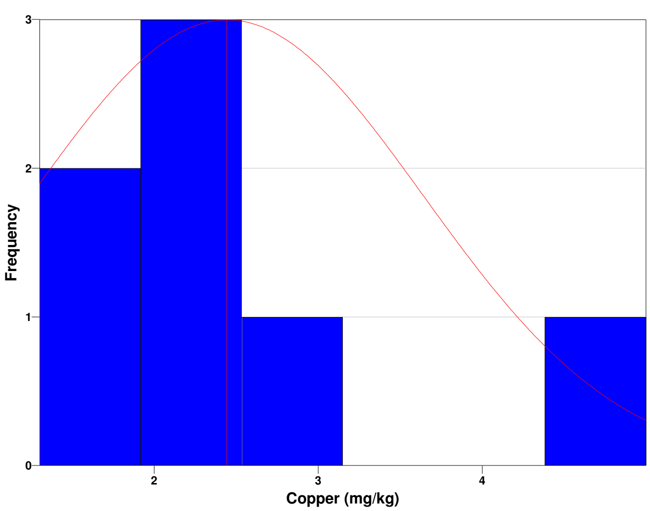
The calculated Shapiro-Wilk test statistic is less than the 10% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 1.3, do not appear to follow a normal distribution at the 10% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

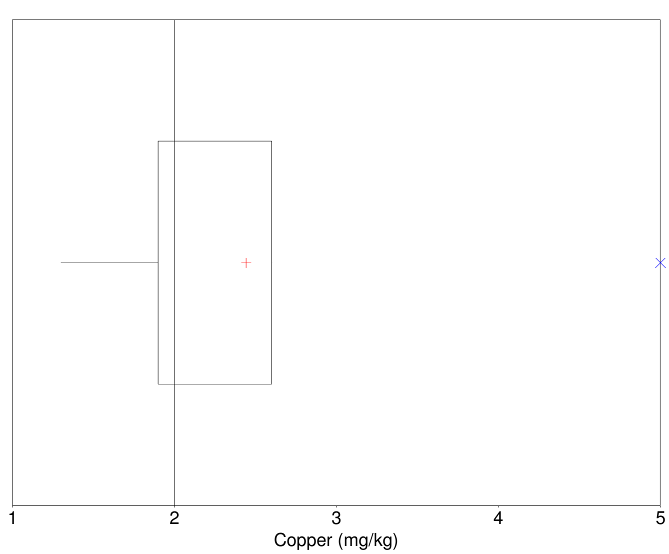
Data Plots for Copper
Graphical displays of the data are shown below.

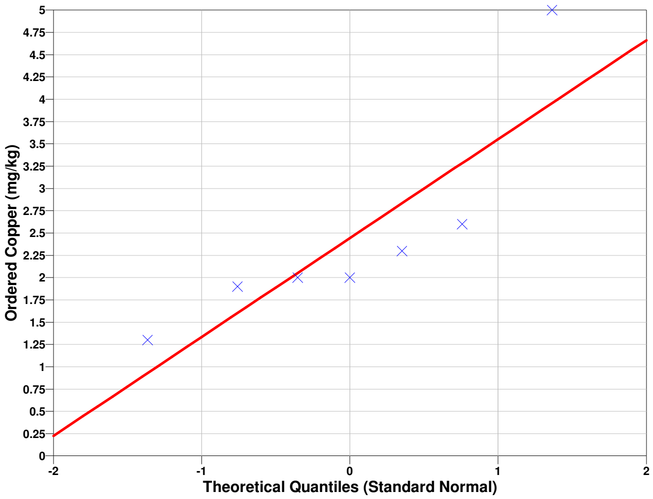
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Copper
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7643
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	3.321
95% Non-Parametric (Chebyshev) UCL	4.413

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (4.413) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-129.58	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Data Analysis for Lead
The following data points were entered by the user for analysis.

Lead (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	2.4	2.5	2.7	2.8	3.1	3.1	4.3			

SUMMARY STATISTICS for Lead								
n	7							
Min	2.4							
Max	4.3							
Range	1.9							
Mean	2.9857							
Median	2.8							
Variance	0.4081							
StdDev	0.63882							
Std Error	0.24145							
Skewness	1.7256							
Interquartile Range	0.6							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
2.4	2.4	2.4	2.5	2.8	3.1	4.3	4.3	4.3

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible

explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Lead	
Dixon Test Statistic	0.052632
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 2.4 is not an outlier at the 10% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8201
Shapiro-Wilk 10% Critical Value	0.826

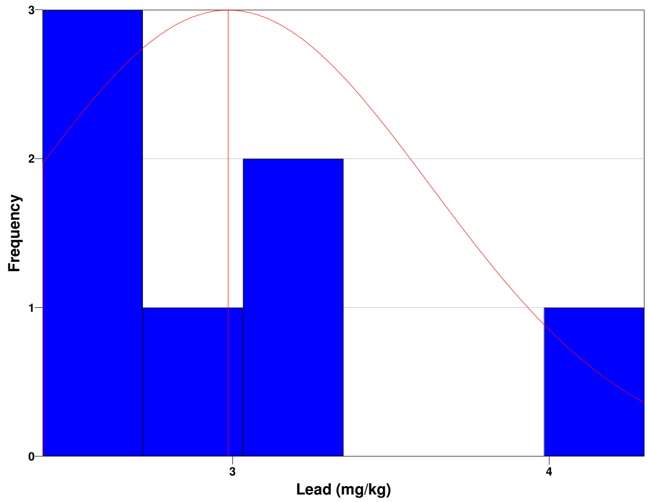
The calculated Shapiro-Wilk test statistic is less than the 10% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 2.4, do not appear to follow a normal distribution at the 10% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

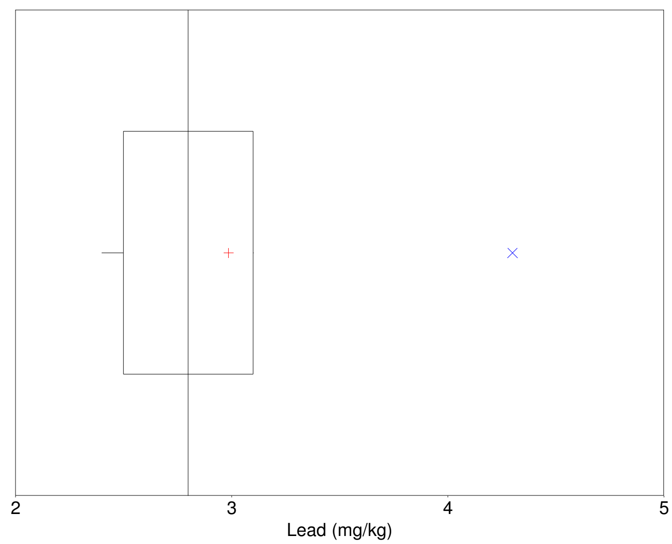
Data Plots for Lead
Graphical displays of the data are shown below.

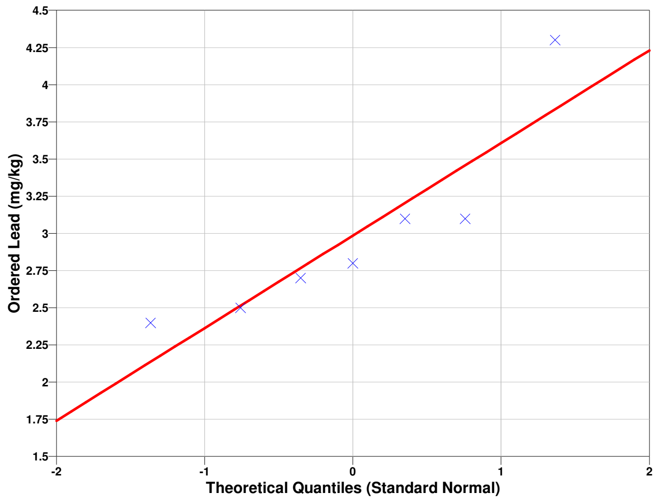
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Lead

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.826
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	3.455

95% Non-Parametric (Chebyshev) UCL	4.038

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (3.455) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-484.63	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Manganese
The following data points were entered by the user for analysis.

Manganese (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	26.9	41.4	42.2	76.3	95.5	113	114			

SUMMARY STATISTICS for Manganese								
n	7							
Min	26.9							
Max	114							
Range	87.1							
Mean	72.757							
Median	76.3							
Variance	1311.7							
StdDev	36.217							
Std Error	13.689							
Skewness	-0.042551							
Interquartile Range	71.6							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**

26.9	26.9	26.9	41.4	76.3	113	114	114	114

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Manganese	
Dixon Test Statistic	0.16648
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 26.9 is not an outlier at the 10% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8596
Shapiro-Wilk 10% Critical Value	0.826

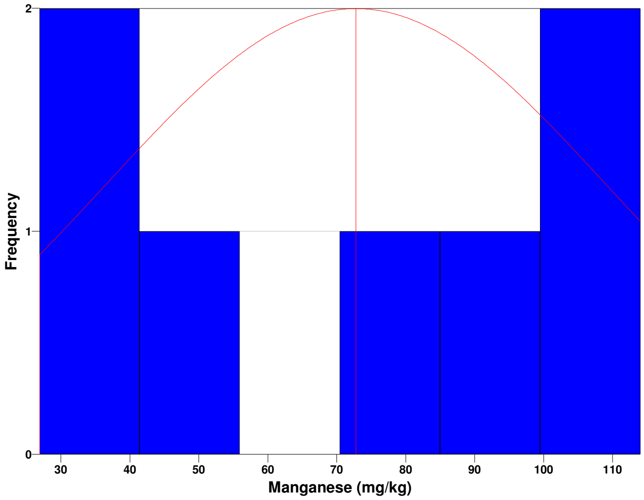
The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 26.9, do appear to follow a normal distribution at the 10% level of significance.

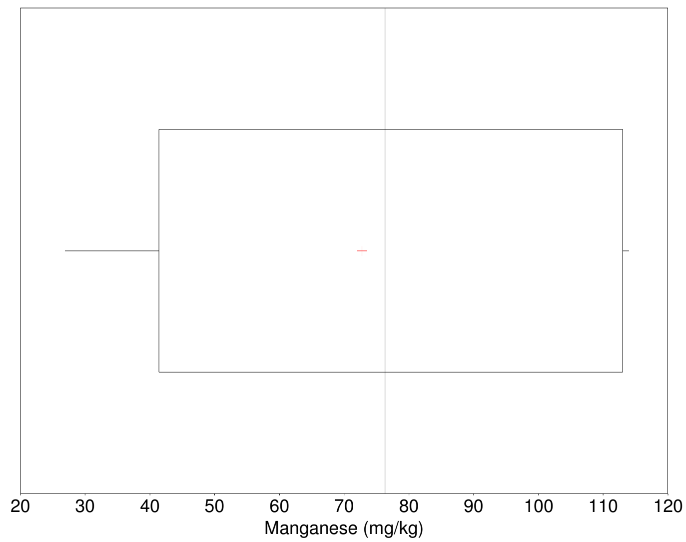
Data Plots for Manganese
Graphical displays of the data are shown below.

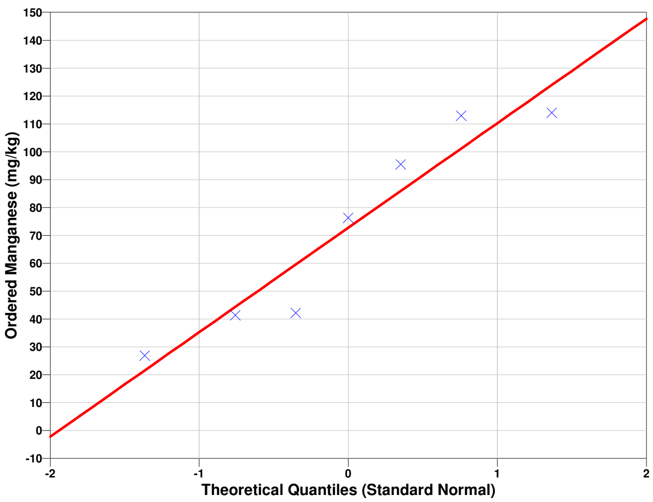
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Manganese
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.885
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	99.36

95% Non-Parametric (Chebyshev) UCL	132.4

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (99.36) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-31.211	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Mercury
The following data points were entered by the user for analysis.

Mercury (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.002	0.0023	0.0059	0.0065	0.012	0.033	0.034			

SUMMARY STATISTICS for Mercury	
n	7
Min	0.002
Max	0.034
Range	0.032
Mean	0.013671
Median	0.0065
Variance	0.0001945
StdDev	0.013946
Std Error	0.0052712
Skewness	1.008
Interquartile Range	0.0307

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**

0.002	0.002	0.002	0.0023	0.0065	0.033	0.034	0.034	0.034

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Mercury	
Dixon Test Statistic	0.009375
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.002 is not an outlier at the 10% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8042
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic is less than the 10% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.002, do not appear to follow a normal distribution at the 10% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

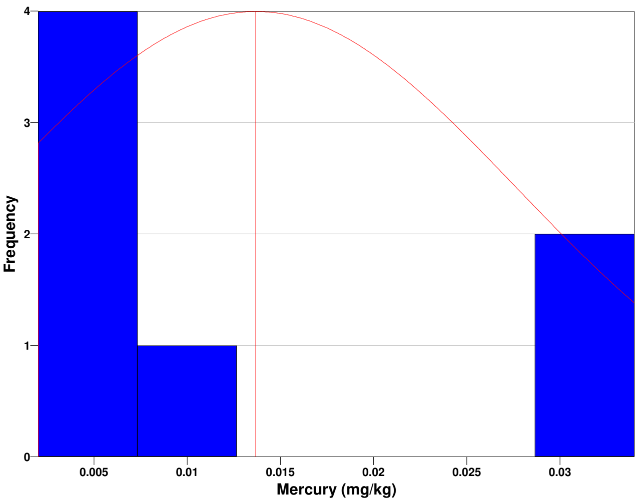
Data Plots for Mercury
Graphical displays of the data are shown below.

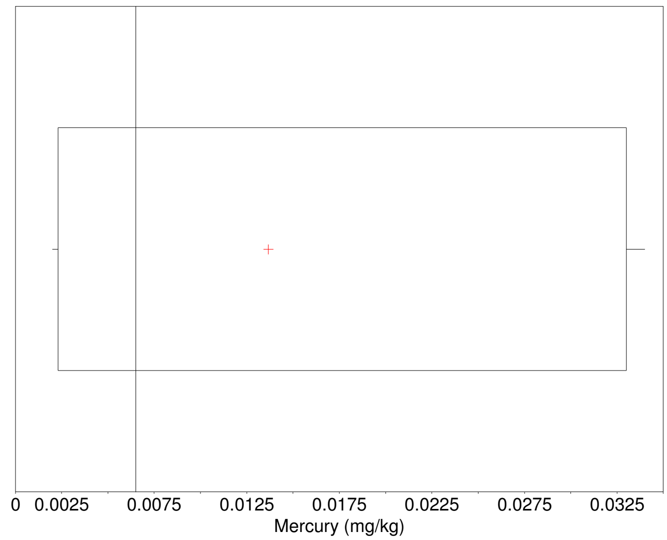
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

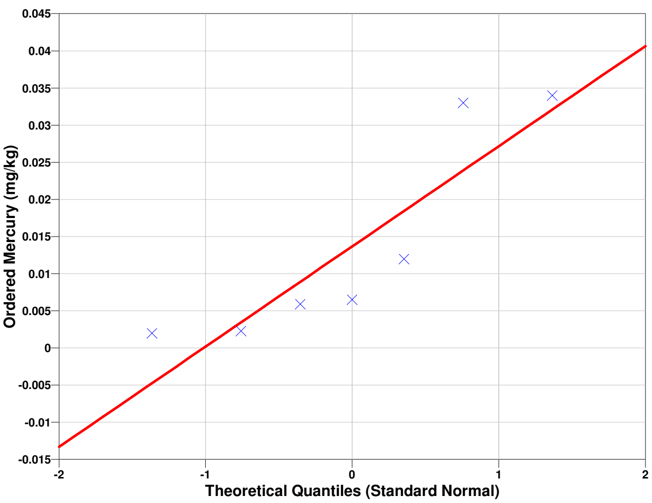
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate

substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Mercury
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7766
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN

95% Parametric UCL	0.02391
95% Non-Parametric (Chebyshev) UCL	0.03665

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.03665) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-16.377	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Data Analysis for Nickel
The following data points were entered by the user for analysis.

Nickel (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1.2	1.2	1.4	1.6	1.8	1.9	2.3			

SUMMARY STATISTICS for Nickel	
n	7
Min	1.2
Max	2.3
Range	1.1
Mean	1.6286
Median	1.6

Variance				0.16238				
StdDev				0.40297				
Std Error				0.15231				
Skewness				0.56458				
Interquartile Range				0.7				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
1.2	1.2	1.2	1.2	1.6	1.9	2.3	2.3	2.3

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Nickel	
Dixon Test Statistic	0
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 1.2 is not an outlier at the 10% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.985
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic exceeds the 10% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 1.2, do appear to follow a normal distribution at the 10% level of significance.

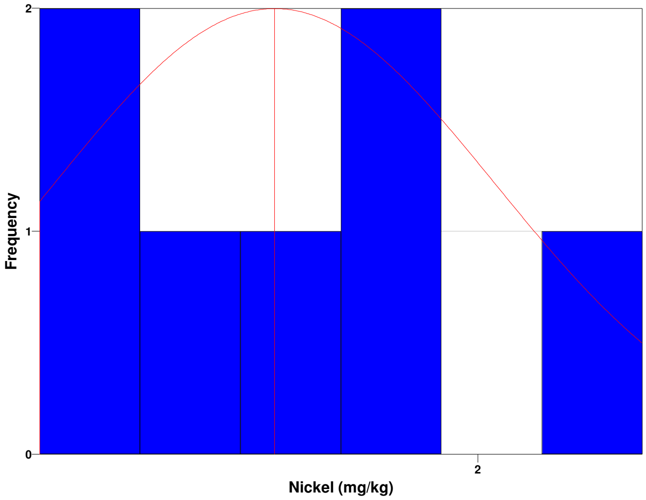
Data Plots for Nickel
Graphical displays of the data are shown below.

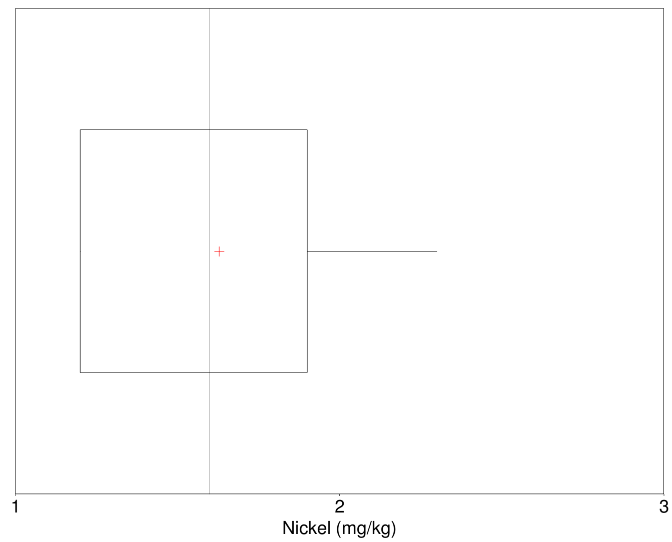
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

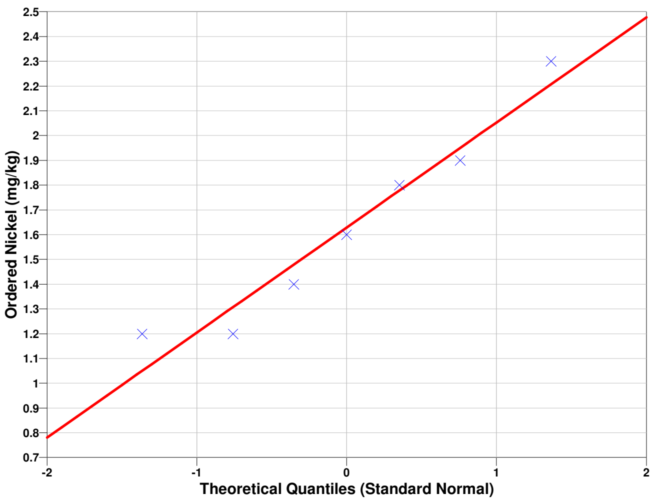
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the

distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Nickel
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9338
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	1.925
95% Non-Parametric (Chebyshev) UCL	2.292

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (1.925) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-186.28	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Toluene
The following data points were entered by the user for analysis.

Toluene (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00075	0.00075	0.00075	0.0016	0.0017	0.0017	0.0018			

SUMMARY STATISTICS for Toluene	
n	7
Min	0.00075
Max	0.0018
Range	0.00105
Mean	0.0012929
Median	0.0016
Variance	2.6119e-007
StdDev	0.00051107

Std Error				0.00019317				
Skewness				-0.32432				
Interquartile Range				0.00095				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00075	0.00075	0.00075	0.00075	0.0016	0.0017	0.0018	0.0018	0.0018

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Toluene	
Dixon Test Statistic	0
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.00075 is not an outlier at the 10% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7386
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic is less than the 10% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.00075, do not appear to follow a normal distribution at the 10% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

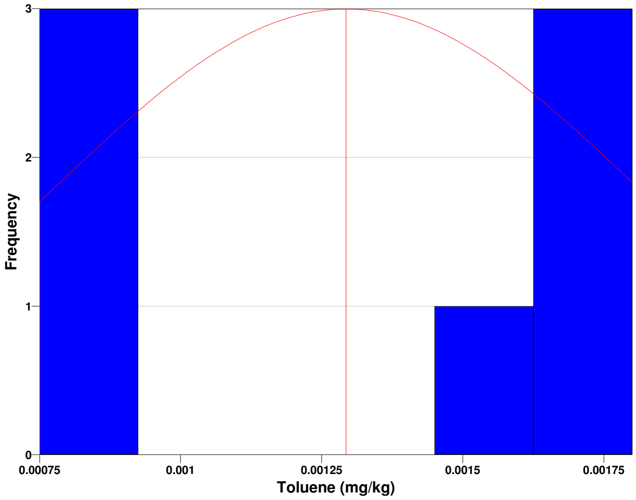
Data Plots for Toluene
Graphical displays of the data are shown below.

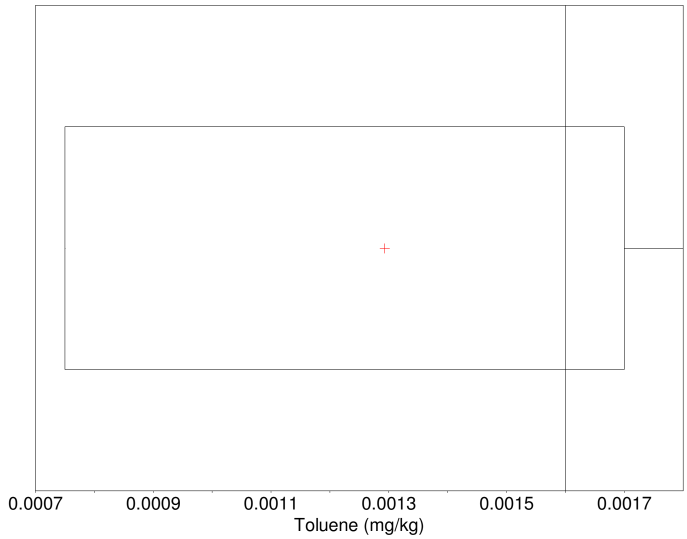
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

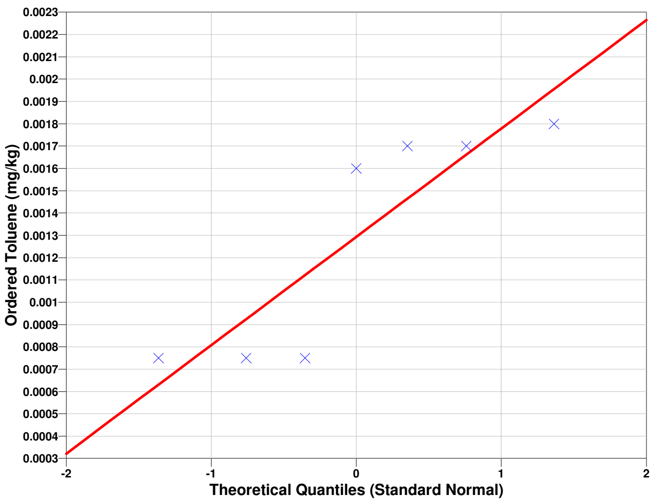
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted

individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Toluene
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7381
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance.

The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.001668
95% Non-Parametric (Chebyshev) UCL	0.002135

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.002135) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.0354e+006	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Data Analysis for Vanadium
The following data points were entered by the user for analysis.

Vanadium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	4.4	4.5	4.6	5.1	5.3	5.5	7.9			

SUMMARY STATISTICS for Vanadium	
n	7

Min				4.4				
Max				7.9				
Range				3.5				
Mean				5.3286				
Median				5.1				
Variance				1.4624				
StdDev				1.2093				
Std Error				0.45707				
Skewness				2.0108				
Interquartile Range				1				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
4.4	4.4	4.4	4.5	5.1	5.5	7.9	7.9	7.9

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Vanadium	
Dixon Test Statistic	0.028571
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 4.4 is not an outlier at the 10% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7768
Shapiro-Wilk 10% Critical Value	0.826

The calculated Shapiro-Wilk test statistic is less than the 10% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 4.4, do not appear to follow a normal distribution at the 10% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

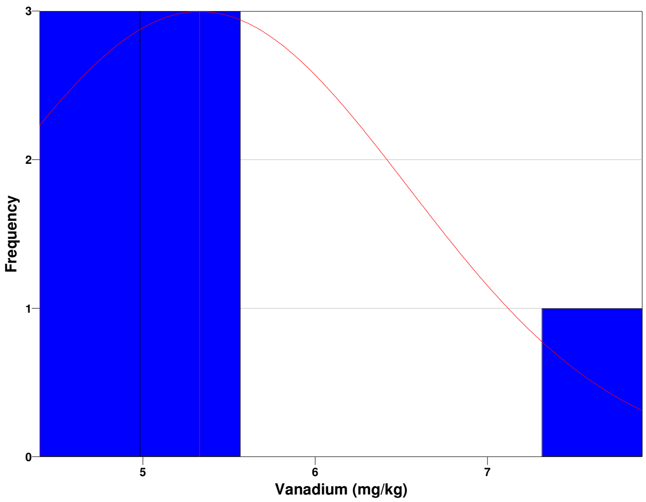
Data Plots for Vanadium
Graphical displays of the data are shown below.

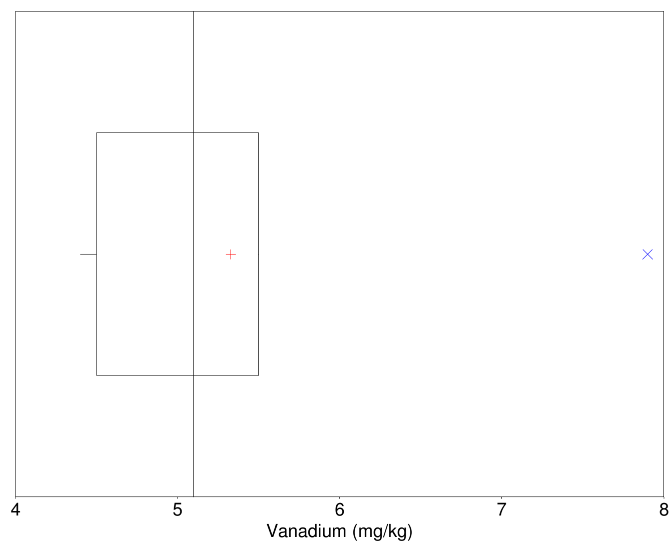
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally

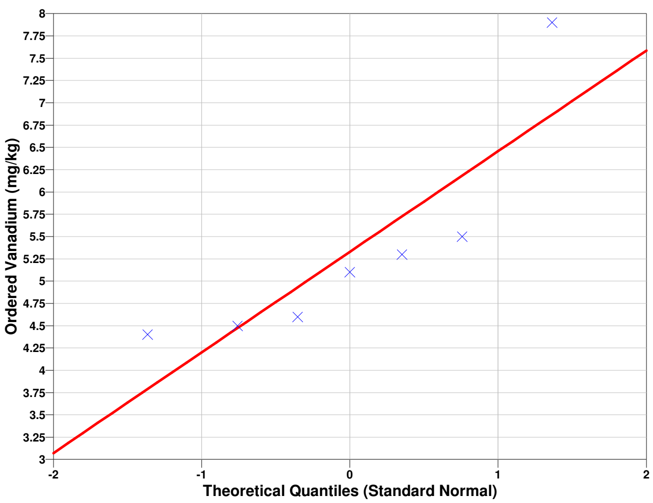
distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Vanadium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was

conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7602
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	6.217
95% Non-Parametric (Chebyshev) UCL	7.321

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (7.321) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
7.2824	1.9432	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
0	6	Cannot Reject
Note: There may not be enough data to reject the null hypothesis (and conclude site is clean) with 95% confidence using the MARSSIM sign test.		

Data Analysis for Zinc
The following data points were entered by the user for analysis.

Zinc (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	8.9	10.2	11.9	13.7	17.5	18.2	35.8			

SUMMARY STATISTICS for Zinc								
n	7							
Min	8.9							
Max	35.8							
Range	26.9							
Mean	16.6							
Median	13.7							
Variance	83.793							
StdDev	9.1539							
Std Error	3.4598							
Skewness	1.897							
Interquartile Range	8							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
8.9	8.9	8.9	10.2	13.7	18.2	35.8	35.8	35.8

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 10% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Zinc	
Dixon Test Statistic	0.048327
Dixon 10% Critical Value	0.434

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 8.9 is not an outlier at the 10% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 10% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7948

Shapiro-Wilk 10% Critical Value	0.826

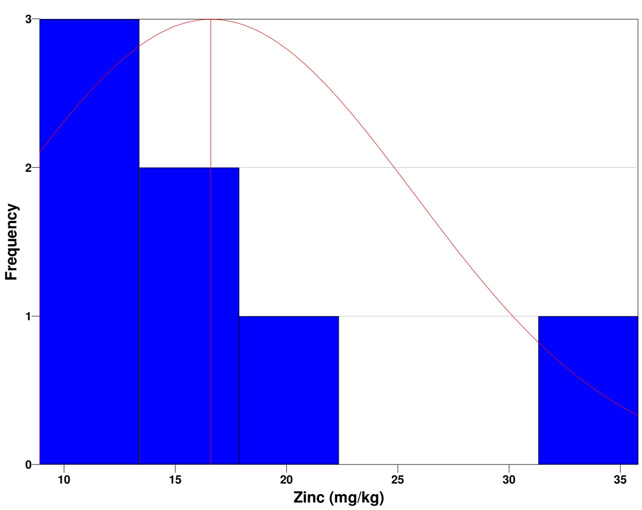
The calculated Shapiro-Wilk test statistic is less than the 10% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 8.9, do not appear to follow a normal distribution at the 10% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

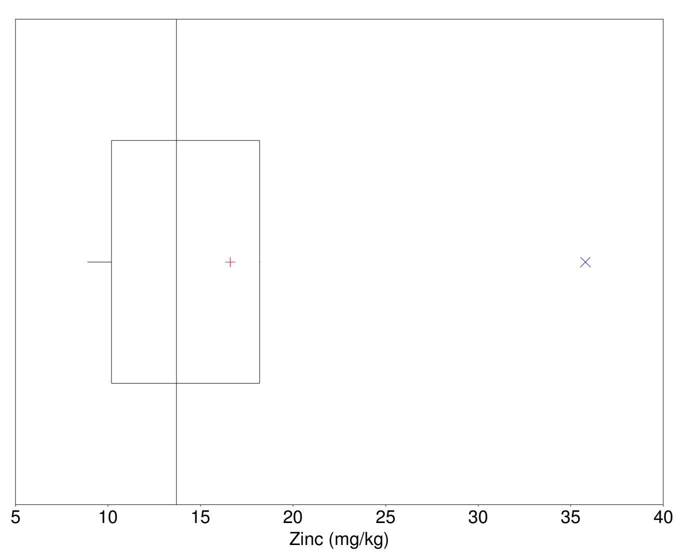
Data Plots for Zinc
Graphical displays of the data are shown below.

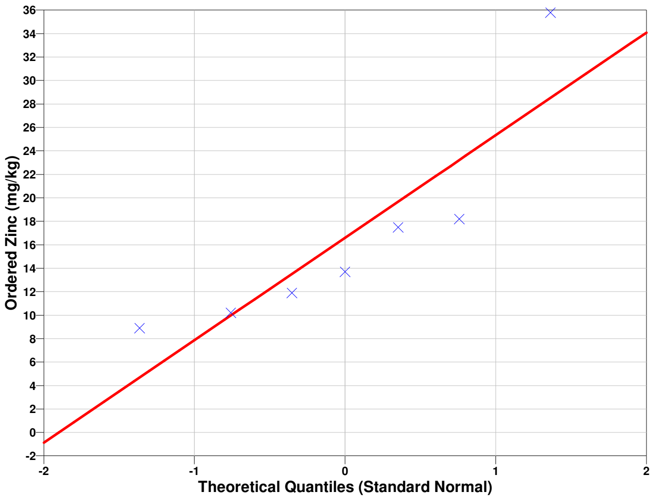
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Zinc

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7937
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	23.32
95% Non-Parametric (Chebyshev) UCL	31.68

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (31.68) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test

A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where

x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-29.886	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Appendix C

VSP Reports of Calculated Minimum Sample Quantity
Report 18
Area of Concern – 3
Minimum Sample Quantity Calculation for Surface Soil using Ecological Benchmarks and Delta Method 2

Random sampling locations for comparing a mean with a fixed threshold (parametric)

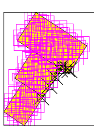
Summary

This report summarizes the sampling design, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design for Chromium, the driving analyte (the analyte which required the largest number of samples). A figure that shows sampling locations in the field and a table that lists sampling location coordinates are also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean to a fixed threshold
Type of Sampling Design	Parametric
Sample Placement (Location) in the Field	Simple random sampling
Working (Null) Hypothesis	The mean value at the site exceeds the threshold
Formula for calculating number of sampling locations	Student's t-test
Calculated total number of samples	92
Number of samples on map [a]	92
Number of selected sample areas [b]	1
Specified sampling area [c]	602117.04 m^2
Total cost of sampling [d]	$47,000.00

[a] This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[d] Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.



Area: Area 1					
X Coord	**Y Coord**	**Label**	**Value**	**Type**	**Historical**
680077.3540	3083115.5330	J-50S		Manual	T
680141.8730	3083080.8800	J-52S		Manual	T
680170.5600	3083064.6740	J-53S		Manual	T
679924.8150	3082872.3490	J-47S		Manual	T
679994.9690	3082983.5100	J-48S		Manual	T
680057.6580	3083072.0750	J-49S		Manual	T
679827.1150	3082729.7460	J-51S		Manual	T

679639.3566	3083056.8774		0	Adaptive-Fill	
679532.0940	3082473.1736		0	Adaptive-Fill	
679950.6206	3083571.7611		0	Adaptive-Fill	
679719.8587	3083374.3746		0	Adaptive-Fill	
680321.8266	3083382.3619		0	Adaptive-Fill	
679517.8854	3082771.2000		0	Adaptive-Fill	
679708.7370	3083684.1121		0	Adaptive-Fill	
679842.6394	3083161.5150		0	Adaptive-Fill	
680079.2113	3083368.1045		0	Adaptive-Fill	
679726.2378	3082556.0490		0	Adaptive-Fill	
679901.2279	3083334.9255		0	Adaptive-Fill	
679616.2594	3083525.1644		0	Adaptive-Fill	
679722.3185	3082883.6220		0	Adaptive-Fill	
680248.8959	3083220.5932		0	Adaptive-Fill	
679409.4906	3082588.5181		0	Adaptive-Fill	
680123.3963	3083532.8314		0	Adaptive-Fill	
679797.8131	3083553.3190		0	Adaptive-Fill	
679671.1736	3082710.4091		0	Adaptive-Fill	
679688.5635	3083199.1978		0	Adaptive-Fill	
679782.3583	3083030.9543		0	Adaptive-Fill	
679586.3977	3082918.7747		0	Adaptive-Fill	
679555.8241	3082639.1246		0	Adaptive-Fill	
679842.2998	3083698.6085		0	Adaptive-Fill	
679585.3293	3083395.7100		0	Adaptive-Fill	
679985.0400	3083227.8025		0	Adaptive-Fill	
680116.9683	3083232.0818		0	Adaptive-Fill	
679996.4272	3083456.0065		0	Adaptive-Fill	
680220.5237	3083460.5675		0	Adaptive-Fill	
679878.6599	3083449.0254		0	Adaptive-Fill	
679791.6282	3083277.1452		0	Adaptive-Fill	
679644.4126	3082428.6621		0	Adaptive-Fill	
679831.4937	3082921.9110		0	Adaptive-Fill	
679927.3611	3083097.2172		0	Adaptive-Fill	
680200.4264	3083335.2910		0	Adaptive-Fill	
679727.3067	3083473.3380		0	Adaptive-Fill	
679614.0500	3082822.1627		0	Adaptive-Fill	
679765.5778	3082640.5449		0	Adaptive-Fill	
679839.1146	3082824.0629		0	Adaptive-Fill	
679650.2302	3082610.0230		0	Adaptive-Fill	
679615.7920	3082525.7148		0	Adaptive-Fill	
679752.8297	3083121.6124		0	Adaptive-Fill	

679472.5542	3082688.7044		0	Adaptive-Fill	
679725.5819	3082779.3102		0	Adaptive-Fill	
679521.6466	3082979.1339		0	Adaptive-Fill	
679682.2594	3082964.7973		0	Adaptive-Fill	
679990.6138	3083369.6319		0	Adaptive-Fill	
679866.2962	3083034.5926		0	Adaptive-Fill	
679794.5389	3083411.7775		0	Adaptive-Fill	
679719.0808	3083576.7924		0	Adaptive-Fill	
679456.6903	3082497.3046		0	Adaptive-Fill	
679626.2280	3083143.4774		0	Adaptive-Fill	
680186.5598	3083148.5310		0	Adaptive-Fill	
679921.4945	3083179.8835		0	Adaptive-Fill	
680299.7946	3083300.0617		0	Adaptive-Fill	
680002.5864	3083144.4479		0	Adaptive-Fill	
680152.9243	3083428.4630		0	Adaptive-Fill	
680045.9962	3083573.2996		0	Adaptive-Fill	
679931.1670	3082945.4230		0	Adaptive-Fill	
679889.9847	3083633.0249		0	Adaptive-Fill	
679879.8006	3083241.5391		0	Adaptive-Fill	
679513.8222	3082575.4586		0	Adaptive-Fill	
679646.2114	3083430.0100		0	Adaptive-Fill	
679985.0431	3083298.8879		0	Adaptive-Fill	
680058.5802	3083490.0407		0	Adaptive-Fill	
679723.7894	3083306.1052		0	Adaptive-Fill	
680050.6435	3083287.0737		0	Adaptive-Fill	
679579.8856	3083462.1082		0	Adaptive-Fill	
679750.3148	3083736.3331		0	Adaptive-Fill	
679787.5766	3083348.1473		0	Adaptive-Fill	
679611.0923	3082997.8215		0	Adaptive-Fill	
679608.2965	3082723.1481		0	Adaptive-Fill	
680253.9858	3083367.8520		0	Adaptive-Fill	
680148.1377	3083297.8076		0	Adaptive-Fill	
679762.0202	3082934.1345		0	Adaptive-Fill	
679692.8363	3082652.2931		0	Adaptive-Fill	
679820.5715	3083641.6511		0	Adaptive-Fill	
679680.3780	3082841.9923		0	Adaptive-Fill	
679829.5037	3083084.6750		0	Adaptive-Fill	
679933.9102	3083399.8259		0	Adaptive-Fill	
679771.5334	3083209.1573		0	Adaptive-Fill	
679772.3372	3083599.4101		0	Adaptive-Fill	
679460.3268	3082622.6774		0	Adaptive-Fill	

679844.4023	3083342.9984		0	Adaptive-Fill	
679700.4794	3083059.6668		0	Adaptive-Fill	
679579.4770	3082422.2299		0	Adaptive-Fill	

Primary Sampling Objective
The primary purpose of sampling at this site is to compare a mean value of a site with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the mean value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the mean value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative hypothesis, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach
A parametric random sampling approach was used to determine the number of samples and to specify sampling locations. A parametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that parametric assumptions are reasonable. These assumptions will be examined in post-sampling data analysis.

Both parametric and non-parametric approaches rely on assumptions about the population. However, non-parametric approaches typically require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than the number of samples required by non-parametric approaches.

Locating the sample points randomly provides data that are separated by many distances, whereas systematic samples are all equidistant apart. Therefore, random sampling provides more information about the spatial structure of the potential contamination than systematic sampling does. As with systematic sampling, random sampling also provides information regarding the mean value, but there is the possibility that areas of the site will not be represented with the same frequency as if uniform grid sampling were performed.

Number of Total Samples: Calculation Equation and Inputs
The equation used to calculate the number of samples is based on a Student's t-test. For this site, the null hypothesis is rejected in favor of the alternative hypothesis if the sample mean is sufficiently smaller than the threshold. The number of samples to collect is calculated so that 1) there will be a high probability ($1-\beta$) of rejecting the null hypothesis if the alternative hypothesis is true and 2) a low probability (α) of rejecting the null hypothesis if the null hypothesis is true.

The formula used to calculate the number of samples is:

$$n = \frac{S^2}{\Delta^2}\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2 + 0.5Z_{1-\alpha}^2$$

where
n is the number of samples,
S is the estimated standard deviation of the measured values including analytical error,
Δ is the width of the gray region,
α is the acceptable probability of incorrectly concluding the site mean is less than the threshold,
β is the acceptable probability of incorrectly concluding the site mean exceeds the threshold,
$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is $1-\alpha$,
$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is $1-\beta$.

The values of these inputs that result in the calculated number of sampling locations are:

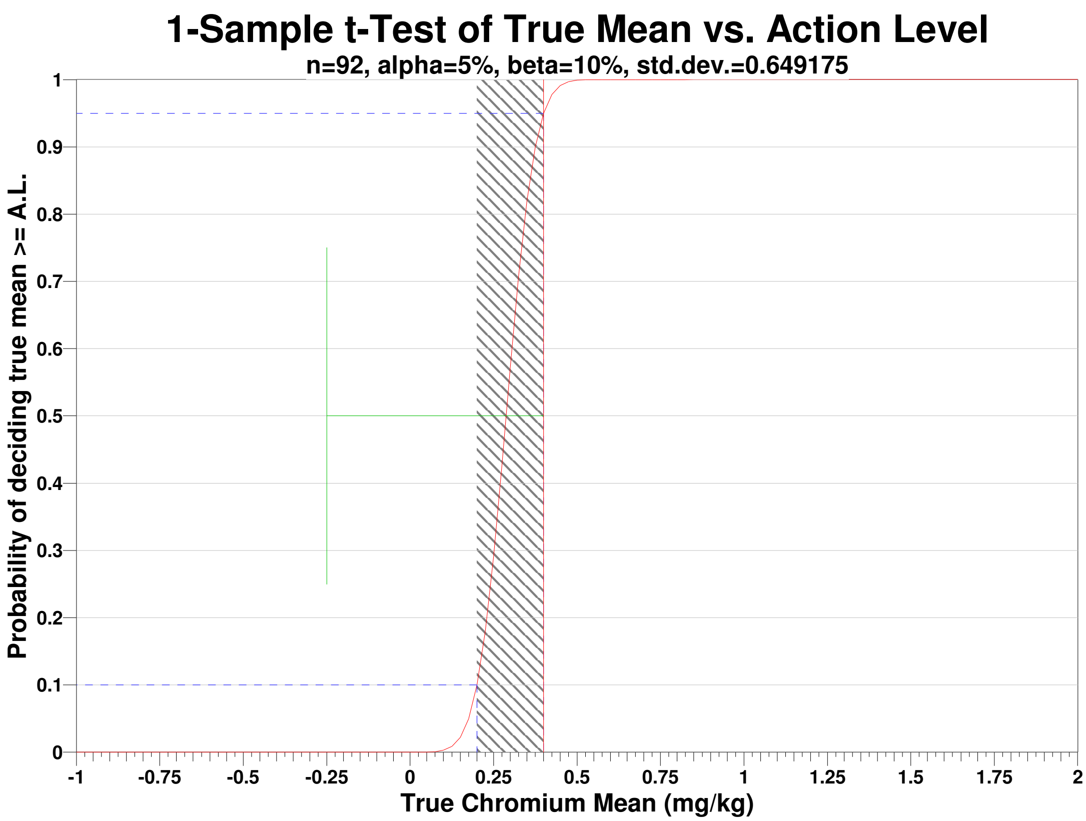
Analyte	n	Parameter					
		S	**Δ**	**α**	**β**	**$Z_{1-\alpha}$** [a]	**$Z_{1-\beta}$** [b]
New Location	2	0.1 mg/kg	10 mg/kg	0.05	0.1	1.64485	1.28155
Arsenic	2	0.640651 mg/kg	9 mg/kg	0.05	0.1	1.64485	1.28155
Barium	3	68.7947 mg/kg	165 mg/kg	0.05	0.1	1.64485	1.28155
Beryllium	2	0.0385894 mg/kg	5 mg/kg	0.05	0.1	1.64485	1.28155

Chromium	92	0.649175 mg/kg	0.2 mg/kg	0.05	0.1	1.64485	1.28155
Cobalt	2	0.200321 mg/kg	6.5 mg/kg	0.05	0.1	1.64485	1.28155
Copper	2	1.19563 mg/kg	30.5 mg/kg	0.05	0.1	1.64485	1.28155
Lead	2	0.638823 mg/kg	60 mg/kg	0.05	0.1	1.64485	1.28155
Manganese	2	36.2173 mg/kg	250 mg/kg	0.05	0.1	1.64485	1.28155
Mercury	3	0.0139463 mg/kg	0.05 mg/kg	0.05	0.1	1.64485	1.28155
Nickel	2	0.0139463 mg/kg	15 mg/kg	0.05	0.1	1.64485	1.28155
Toluene	2	0.000511068 mg/kg	100 mg/kg	0.05	0.1	1.64485	1.28155
Vanadium	14	1.20929 mg/kg	1 mg/kg	0.05	0.1	1.64485	1.28155
Zinc	2	9.15387 mg/kg	60 mg/kg	0.05	0.1	1.64485	1.28155

[a] This value is automatically calculated by VSP based upon the user defined value of α.
[b] This value is automatically calculated by VSP based upon the user defined value of β.

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000) for Chromium, the driving analyte. It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true mean values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at 1-α on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at 1-α. If any of the inputs change, the number of samples that result in the correct curve changes.



Statistical Assumptions

The assumptions associated with the formulas for computing the number of samples are:

1. the sample mean is normally distributed (this happens if the data are roughly symmetric or the sample size is more than 30; for extremely skewed data sets, additional samples may be required for the sample mean to be normally distributed),
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected randomly.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the sample locations were selected using a random process.

Sensitivity Analysis

The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that μ > action level and alpha (%), probability of mistakenly concluding that μ < action level. The following table shows the results of this analysis.

Number of Samples							
AL=120		**α=5**		**α=10**		**α=15**	
		s=18.3077	**s=9.15387**	**s=18.3077**	**s=9.15387**	**s=18.3077**	**s=9.15387**
LBGR=90	**β=5**	2267067	566768	1793985	448497	1506040	376511
	β=10	1793985	448498	1376202	344051	1125566	281392
	β=15	1506040	376512	1125567	281393	900104	225027
LBGR=80	**β=5**	566768	141693	448497	112125	376511	94128
	β=10	448498	112126	344051	86014	281392	70349
	β=15	376512	94129	281393	70349	225027	56257
LBGR=70	**β=5**	251898	62976	199333	49834	167339	41835
	β=10	199333	49835	152912	38229	125064	31267
	β=15	167339	41836	125064	31267	100012	25004

s = Standard Deviation
LBGR = Lower Bound of Gray Region (% of Action Level)
β = Beta (%), Probability of mistakenly concluding that μ > action level
α = Alpha (%), Probability of mistakenly concluding that μ < action level
AL = Action Level (Threshold)

Cost of Sampling

The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that are based on the number of samples collected and measured. Based on the numbers of samples determined above, the estimated total cost of sampling and analysis at this site is $47,000.00, which averages out to a per sample cost of $510.87. The following table summarizes the inputs and resulting cost estimates.

COST INFORMATION			
Cost Details	**Per Analysis**	**Per Sample**	**92 Samples**
Field collection costs		$100.00	$9,200.00
Analytical costs	$400.00	$400.00	$36,800.00
Sum of Field & Analytical costs		**$500.00**	**$46,000.00**
Fixed planning and validation costs			$1,000.00
Total cost			**$47,000.00**

Data Analysis for New Location

The following data points were entered by the user for analysis.

New Location (mg/kg)

Rank	1	2	3	4	5	6	7	8	9	10
0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0	0
80	0	0	0	0	0					

SUMMARY STATISTICS for New Location								
n	85							
Min	0							
Max	0							
Range	0							
Mean	0							
Median	0							
Variance	0							
StdDev	0							
Std Error	0							
Skewness	-1.#IND							
Interquartile Range	0							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0	0	0	0	0	0	0	0	0

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for New Location			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	0	-1	Yes

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is

recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Lilliefors test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Lilliefors Test Statistic	1.061e+292
Lilliefors 5% Critical Value	1.376e-313

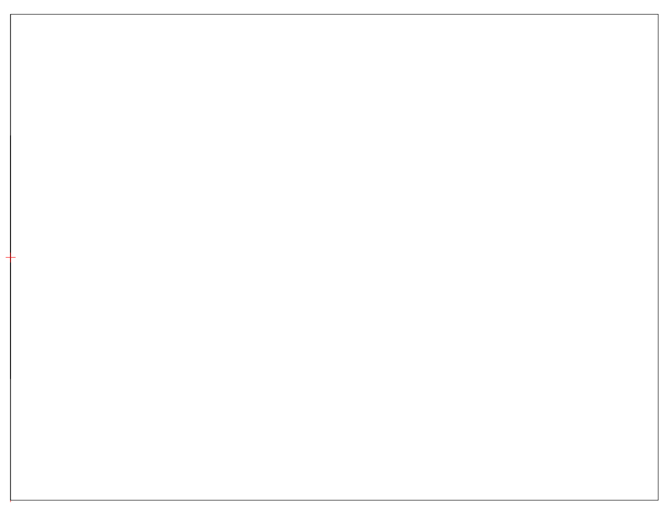
The calculated Lilliefors test statistic exceeds the 5% Lilliefors critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

Data Plots for New Location
Graphical displays of the data are shown below.

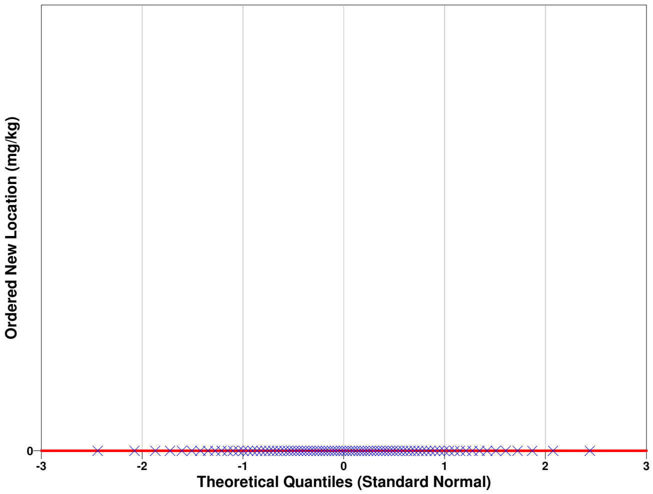
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.



New Location (mg/kg)



For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for New Location
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Lilliefors test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Lilliefors Test Statistic	0
Lilliefors 5% Critical Value	0.0961

The calculated Lilliefors test statistic is less than the 5% Lilliefors critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0
95% Non-Parametric (Chebyshev) UCL	0

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=85 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=84 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.#IND	1.6632	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Data Analysis for Arsenic
The following data points were entered by the user for analysis.

Arsenic (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.52	0.63	0.69	1.1	1.2	1.3	2.4			

SUMMARY STATISTICS for Arsenic								
n	7							
Min	0.52							
Max	2.4							
Range	1.88							
Mean	1.12							
Median	1.1							
Variance	0.41043							
StdDev	0.64065							
Std Error	0.24214							
Skewness	1.5							
Interquartile Range	0.67							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.52	0.52	0.52	0.63	1.1	1.3	2.4	2.4	2.4

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Arsenic	
Dixon Test Statistic	0.058511
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.52 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8507
Shapiro-Wilk 5% Critical Value	0.788

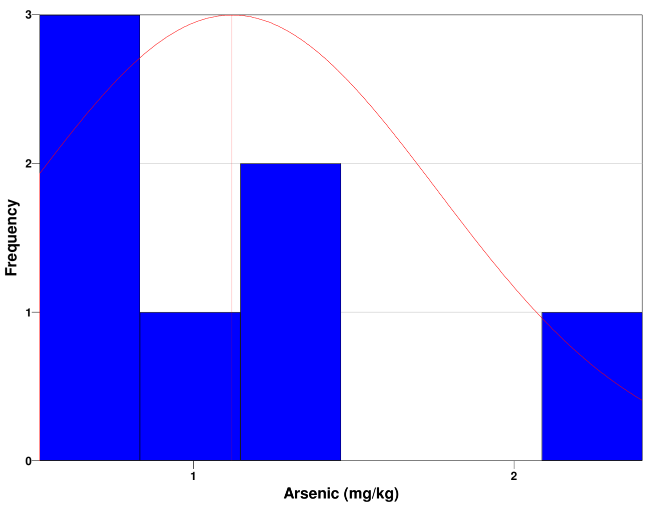
The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.52, do appear to follow a normal distribution at the 5% level of significance.

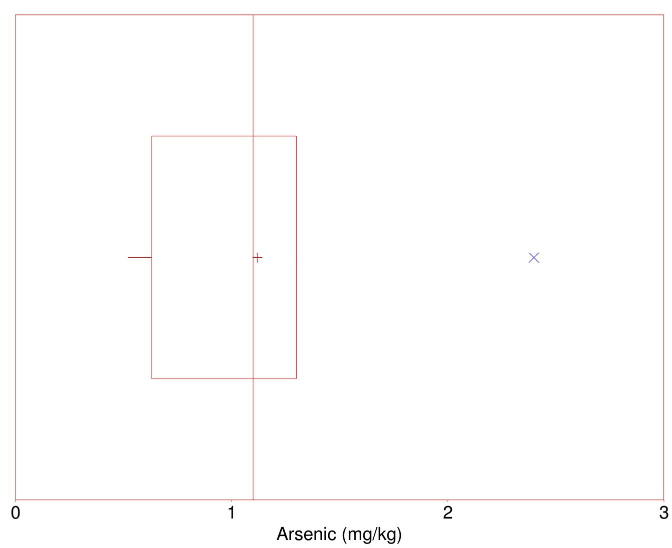
Data Plots for Arsenic
Graphical displays of the data are shown below.

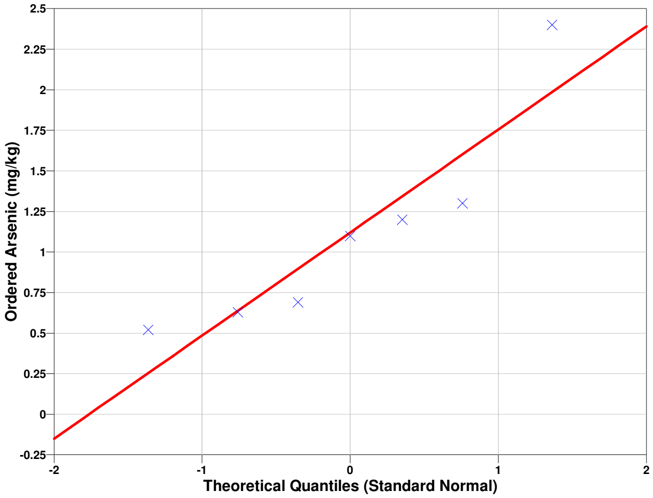
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Arsenic

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8495
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	1.591
95% Non-Parametric (Chebyshev) UCL	2.175

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (1.591) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test

A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where

x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-69.711	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Barium
The following data points were entered by the user for analysis.

Barium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	17.9	21.6	22.3	24.3	45.5	45.7	209			

SUMMARY STATISTICS for Barium								
n	7							
Min	17.9							
Max	209							
Range	191.1							
Mean	55.186							
Median	24.3							
Variance	4732.7							
StdDev	68.795							
Std Error	26.002							
Skewness	2.4958							
Interquartile Range	24.1							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
17.9	17.9	17.9	21.6	24.3	45.7	209	209	209

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Barium	
Dixon Test Statistic	0.019362
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 17.9 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6209
Shapiro-Wilk 5% Critical Value	0.788

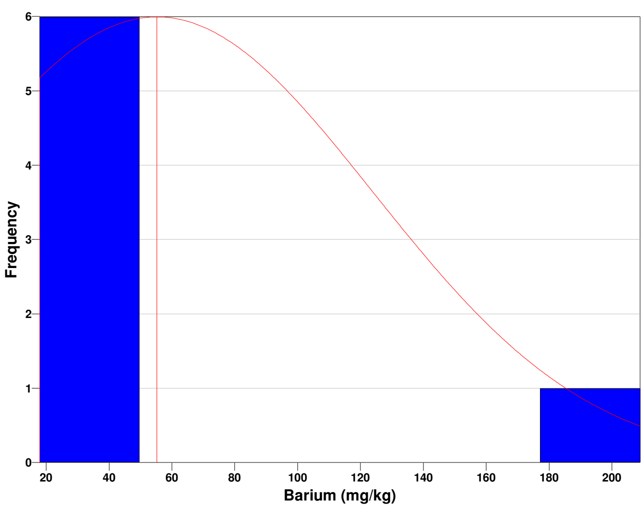
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 17.9, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

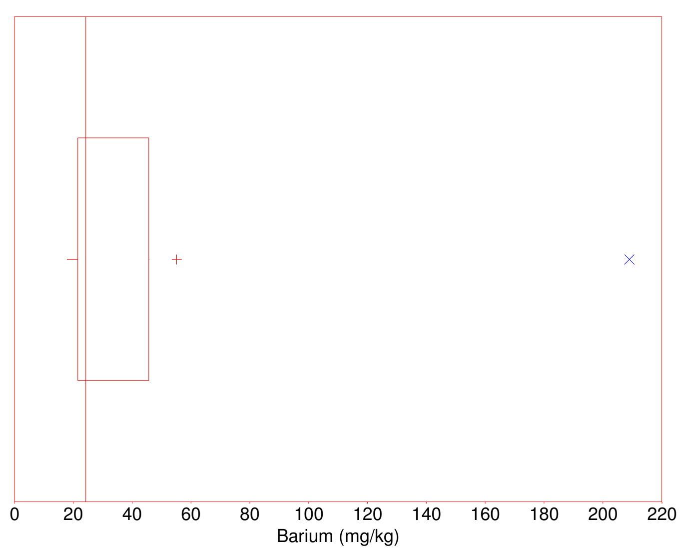
Data Plots for Barium
Graphical displays of the data are shown below.

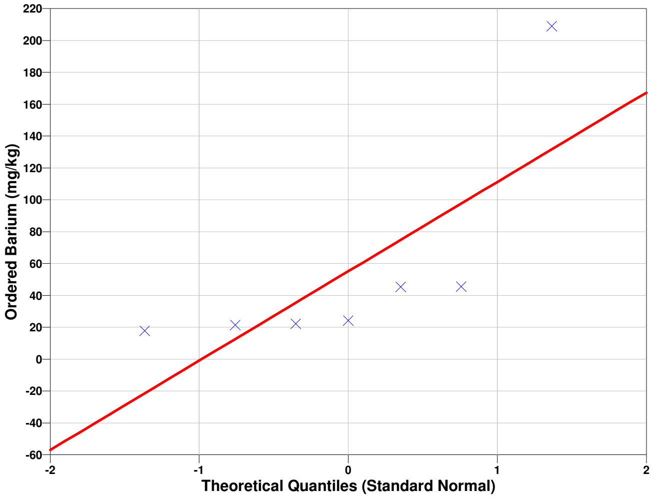
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Barium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5921
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	105.7
95% Non-Parametric (Chebyshev) UCL	168.5

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (168.5) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-10.569	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Data Analysis for Beryllium
The following data points were entered by the user for analysis.

Beryllium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.098	0.13	0.14	0.18	0.19	0.19	0.2			

SUMMARY STATISTICS for Beryllium								
n				7				
Min				0.098				
Max				0.2				
Range				0.102				
Mean				0.16114				
Median				0.18				
Variance				0.0014891				
StdDev				0.038589				
Std Error				0.014585				
Skewness				-0.72264				
Interquartile Range				0.06				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.098	0.098	0.098	0.13	0.18	0.19	0.2	0.2	0.2

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible

explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Beryllium	
Dixon Test Statistic	0.31373
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.098 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8383
Shapiro-Wilk 5% Critical Value	0.788

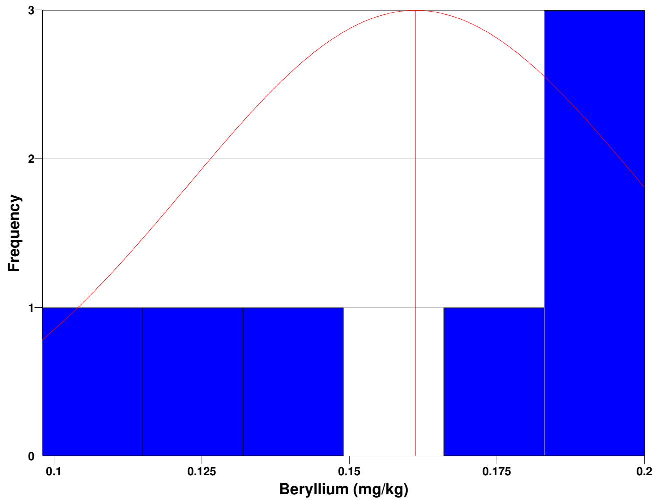
The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.098, do appear to follow a normal distribution at the 5% level of significance.

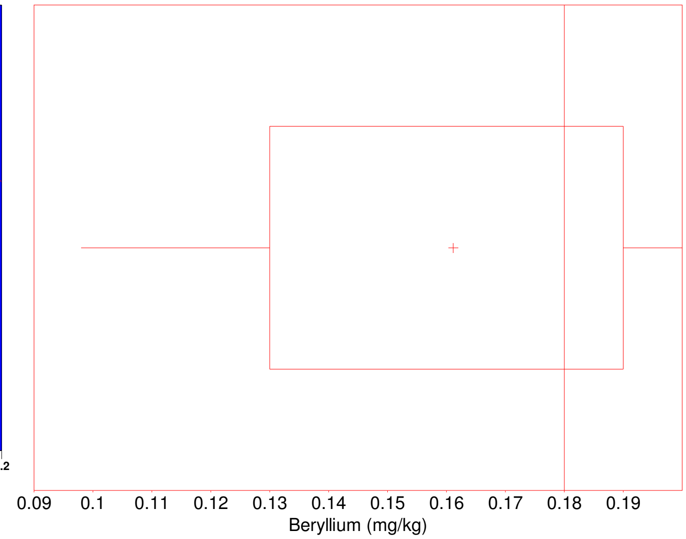
Data Plots for Beryllium
Graphical displays of the data are shown below.

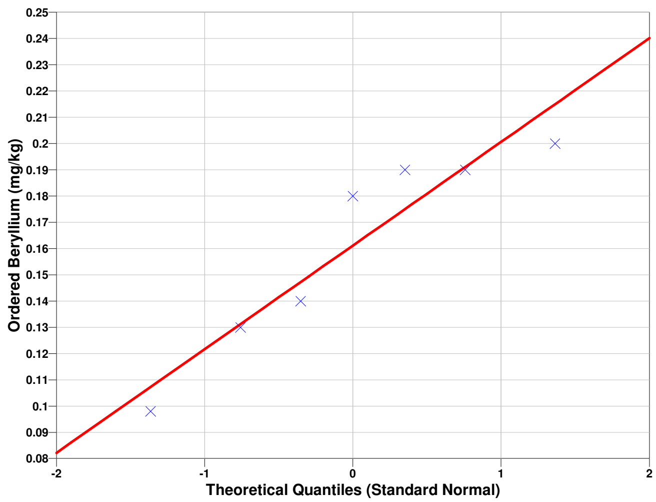
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Beryllium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8819
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.1895

95% Non-Parametric (Chebyshev) UCL	0.2247

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0.1895) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-674.57	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Chromium
The following data points were entered by the user for analysis.

Chromium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	2.2	2.7	3.2	3.4	3.6	3.9	4			

SUMMARY STATISTICS for Chromium								
n	7							
Min	2.2							
Max	4							
Range	1.8							
Mean	3.2857							
Median	3.4							
Variance	0.42143							
StdDev	0.64918							
Std Error	0.24537							
Skewness	-0.72718							
Interquartile Range	1.2							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**

2.2	2.2	2.2	2.7	3.4	3.9	4	4	4

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Chromium	
Dixon Test Statistic	0.27778
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 2.2 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9558
Shapiro-Wilk 5% Critical Value	0.788

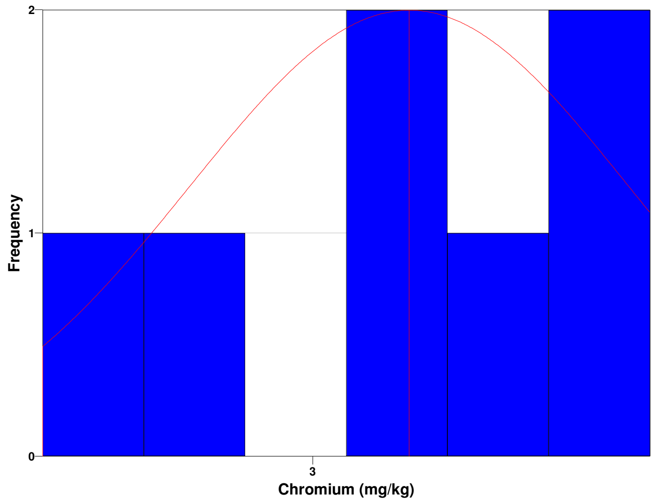
The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 2.2, do appear to follow a normal distribution at the 5% level of significance.

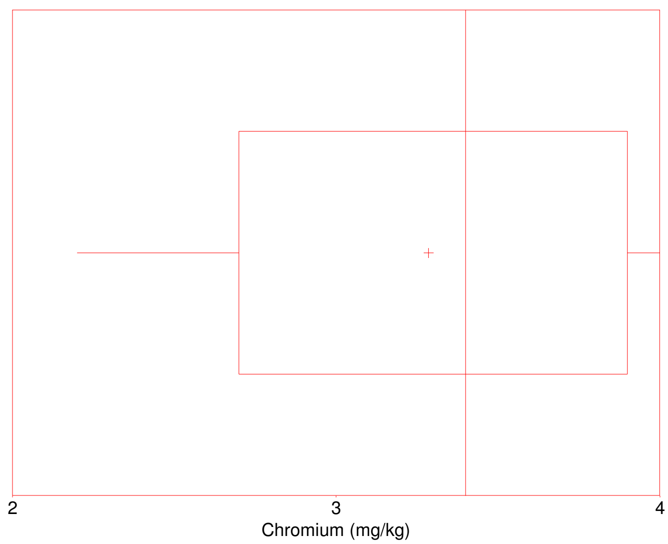
Data Plots for Chromium
Graphical displays of the data are shown below.

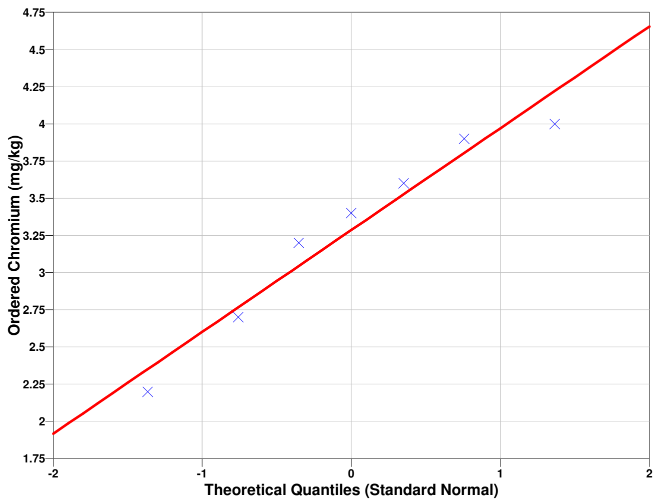
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Chromium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.94
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	3.763

95% Non-Parametric (Chebyshev) UCL	4.355

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (3.763) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
11.761	1.9432	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Data Analysis for Cobalt
The following data points were entered by the user for analysis.

Cobalt (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.6	0.63	0.8	0.81	0.88	1.1	1.1			

SUMMARY STATISTICS for Cobalt								
n	7							
Min	0.6							
Max	1.1							
Range	0.5							
Mean	0.84571							
Median	0.81							
Variance	0.040129							
StdDev	0.20032							
Std Error	0.075714							
Skewness	0.22963							
Interquartile Range	0.47							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**

0.6	0.6	0.6	0.63	0.81	1.1	1.1	1.1	1.1

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Cobalt	
Dixon Test Statistic	0.06
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.6 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9047
Shapiro-Wilk 5% Critical Value	0.788

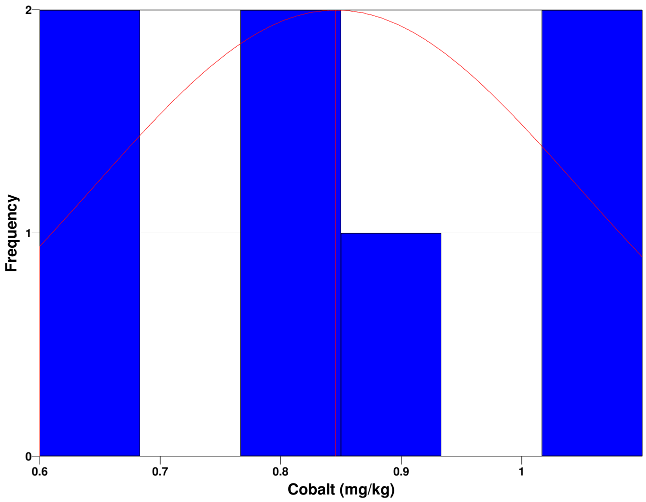
The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.6, do appear to follow a normal distribution at the 5% level of significance.

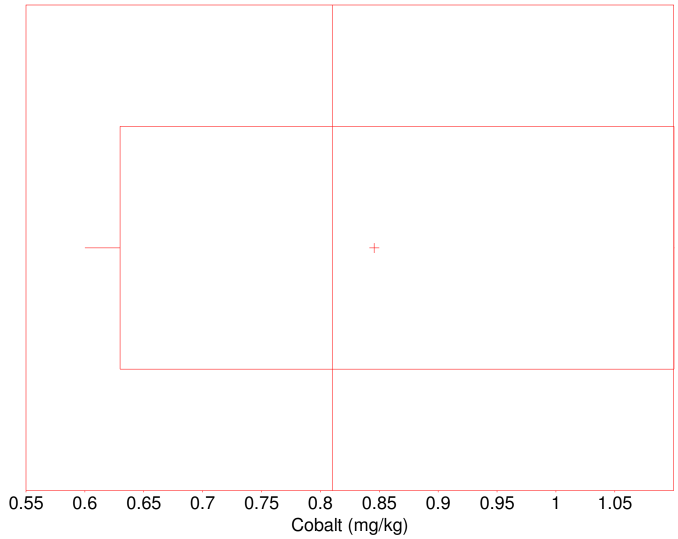
Data Plots for Cobalt
Graphical displays of the data are shown below.

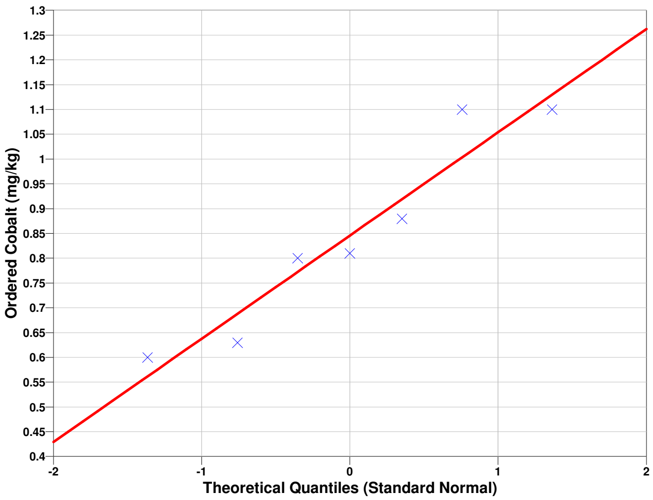
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Cobalt

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8993
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.9928

95% Non-Parametric (Chebyshev) UCL	1.176

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0.9928) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-160.53	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Copper
The following data points were entered by the user for analysis.

Copper (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1.3	1.9	2	2	2.3	2.6	5			

SUMMARY STATISTICS for Copper	
n	7
Min	1.3
Max	5
Range	3.7
Mean	2.4429
Median	2
Variance	1.4295
StdDev	1.1956
Std Error	0.4519
Skewness	2.0335
Interquartile Range	0.7

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**

1.3	1.3	1.3	1.9	2	2.6	5	5	5

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Copper	
Dixon Test Statistic	0.16216
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 1.3 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6789
Shapiro-Wilk 5% Critical Value	0.788

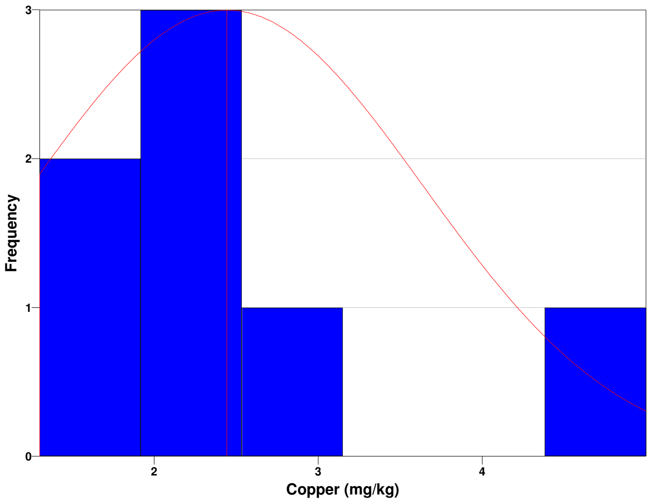
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 1.3, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

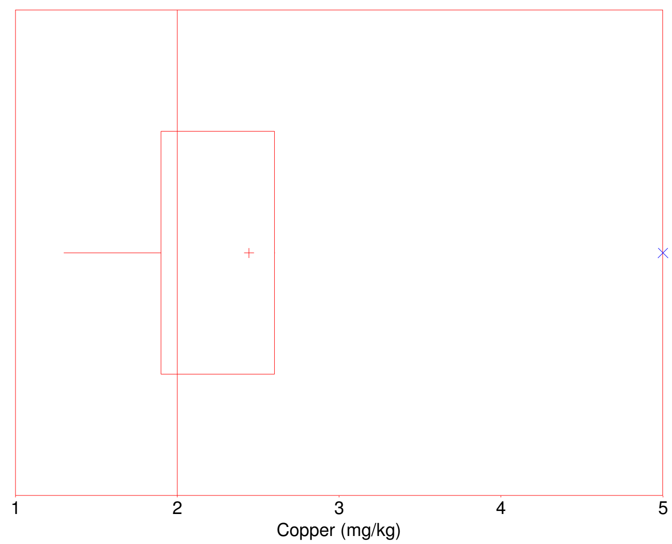
Data Plots for Copper
Graphical displays of the data are shown below.

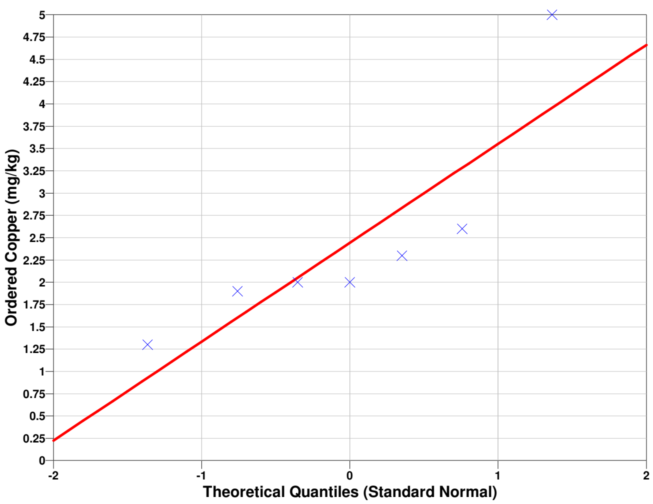
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Copper

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7643
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	3.321

95% Non-Parametric (Chebyshev) UCL	4.413

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (4.413) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-129.58	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Data Analysis for Lead
The following data points were entered by the user for analysis.

Lead (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	2.4	2.5	2.7	2.8	3.1	3.1	4.3			

SUMMARY STATISTICS for Lead	
n	7
Min	2.4
Max	4.3
Range	1.9
Mean	2.9857
Median	2.8
Variance	0.4081

StdDev				0.63882				
Std Error				0.24145				
Skewness				1.7256				
Interquartile Range				0.6				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
2.4	2.4	2.4	2.5	2.8	3.1	4.3	4.3	4.3

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Lead	
Dixon Test Statistic	0.052632
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 2.4 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8201
Shapiro-Wilk 5% Critical Value	0.788

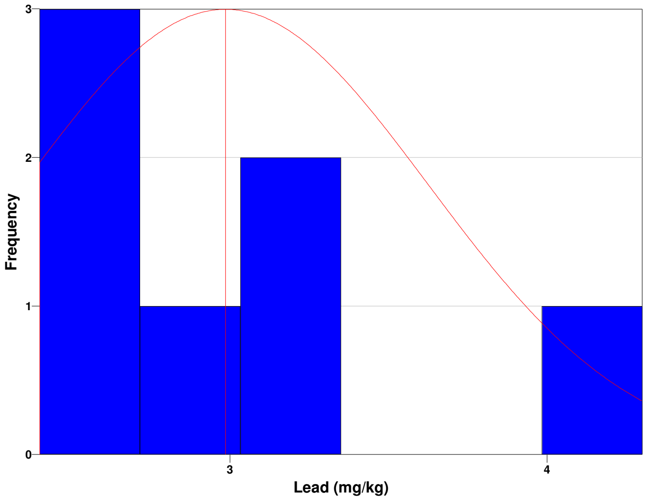
The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 2.4, do appear to follow a normal distribution at the 5% level of significance.

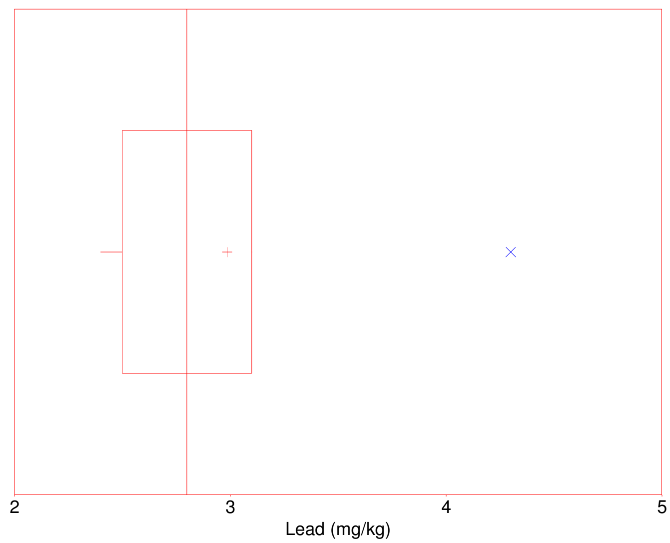
Data Plots for Lead
Graphical displays of the data are shown below.

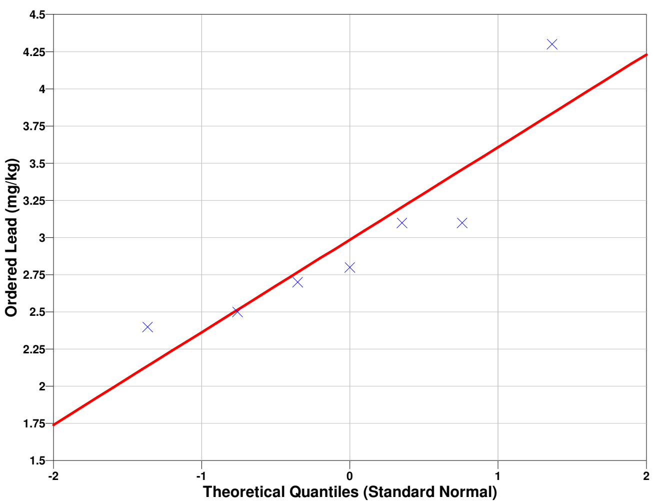
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Lead
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.826
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that

assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	3.455
95% Non-Parametric (Chebyshev) UCL	4.038

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (3.455) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-484.63	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Manganese
The following data points were entered by the user for analysis.

Manganese (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	26.9	41.4	42.2	76.3	95.5	113	114			

SUMMARY STATISTICS for Manganese	
n	7
Min	26.9
Max	114
Range	87.1
Mean	72.757
Median	76.3
Variance	1311.7
StdDev	36.217
Std Error	13.689
Skewness	-0.042551

Interquartile Range				71.6				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
26.9	26.9	26.9	41.4	76.3	113	114	114	114

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Manganese	
Dixon Test Statistic	0.16648
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 26.9 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8596
Shapiro-Wilk 5% Critical Value	0.788

The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 26.9, do appear to follow a normal distribution at the 5% level of significance.

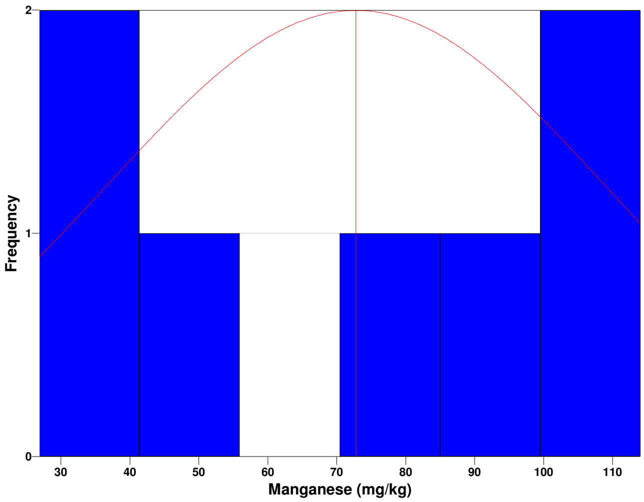
Data Plots for Manganese
Graphical displays of the data are shown below.

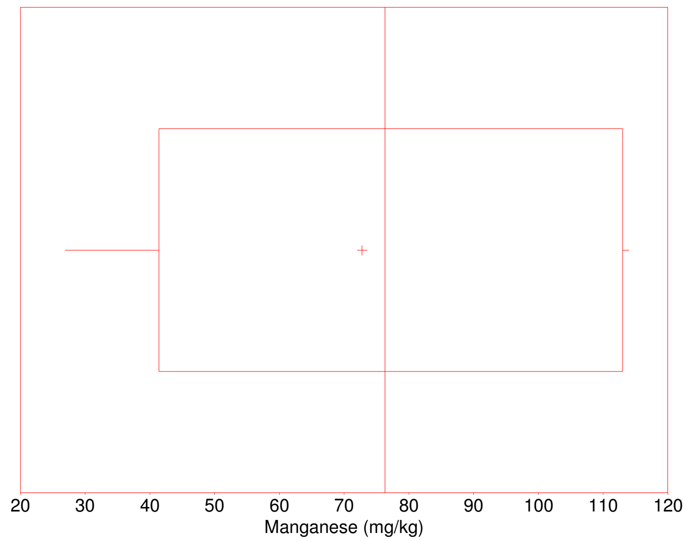
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

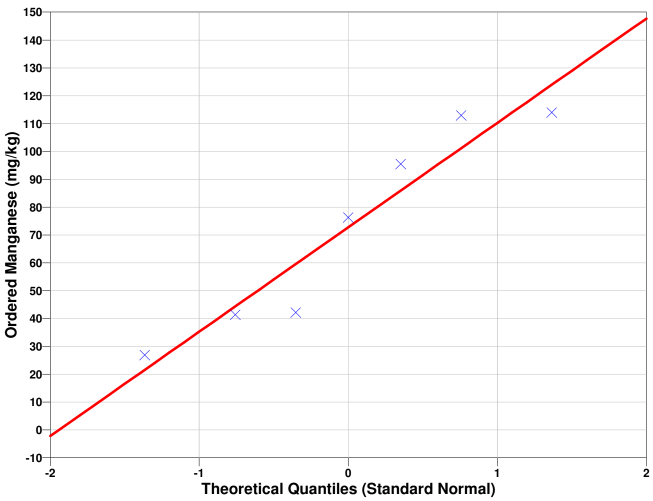
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight

line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Manganese
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.885
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN

95% Parametric UCL	99.36
95% Non-Parametric (Chebyshev) UCL	132.4

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (99.36) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-31.211	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Mercury
The following data points were entered by the user for analysis.

Mercury (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.002	0.0023	0.0059	0.0065	0.012	0.033	0.034			

SUMMARY STATISTICS for Mercury	
n	7
Min	0.002
Max	0.034
Range	0.032
Mean	0.013671
Median	0.0065
Variance	0.0001945
StdDev	0.013946
Std Error	0.0052712
Skewness	1.008
Interquartile Range	0.0307
Percentiles	

1%	5%	10%	25%	50%	75%	90%	95%	99%
0.002	0.002	0.002	0.0023	0.0065	0.033	0.034	0.034	0.034

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Mercury	
Dixon Test Statistic	0.009375
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.002 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8042
Shapiro-Wilk 5% Critical Value	0.788

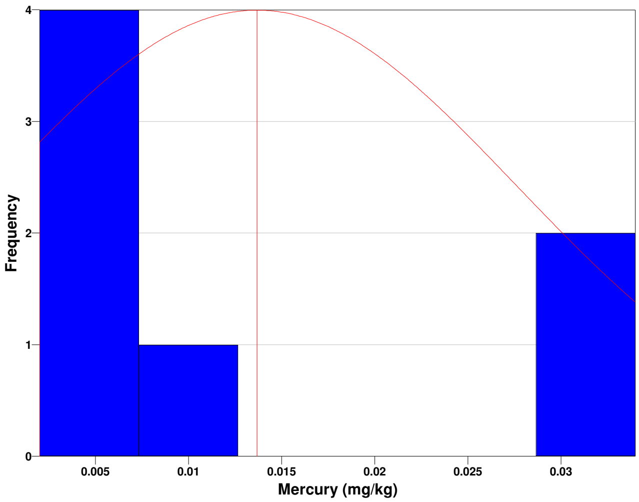
The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.002, do appear to follow a normal distribution at the 5% level of significance.

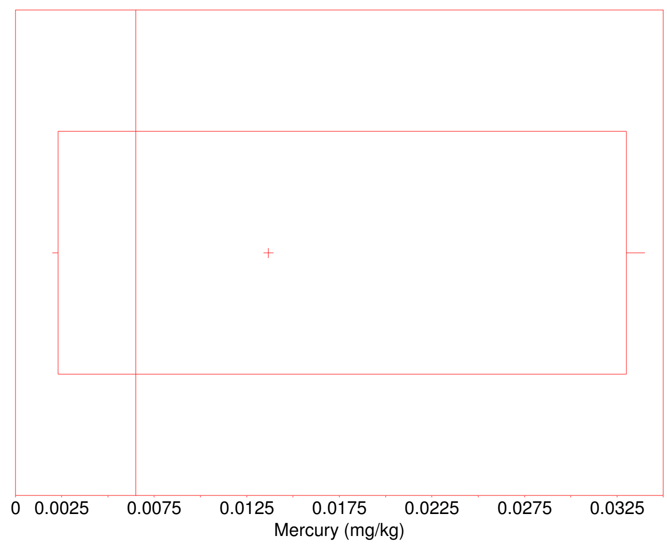
Data Plots for Mercury
Graphical displays of the data are shown below.

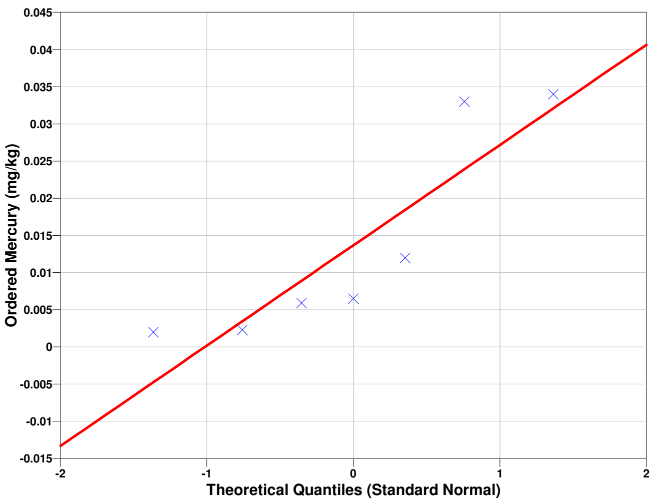
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Mercury
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7766
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.02391

95% Non-Parametric (Chebyshev) UCL	0.03665

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.03665) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-16.377	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Data Analysis for Nickel
The following data points were entered by the user for analysis.

Nickel (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1.2	1.2	1.4	1.6	1.8	1.9	2.3			

SUMMARY STATISTICS for Nickel	
n	7
Min	1.2
Max	2.3
Range	1.1
Mean	1.6286
Median	1.6
Variance	0.16238

StdDev				0.40297				
Std Error				0.15231				
Skewness				0.56458				
Interquartile Range				0.7				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
1.2	1.2	1.2	1.2	1.6	1.9	2.3	2.3	2.3

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Nickel	
Dixon Test Statistic	0
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 1.2 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.985
Shapiro-Wilk 5% Critical Value	0.788

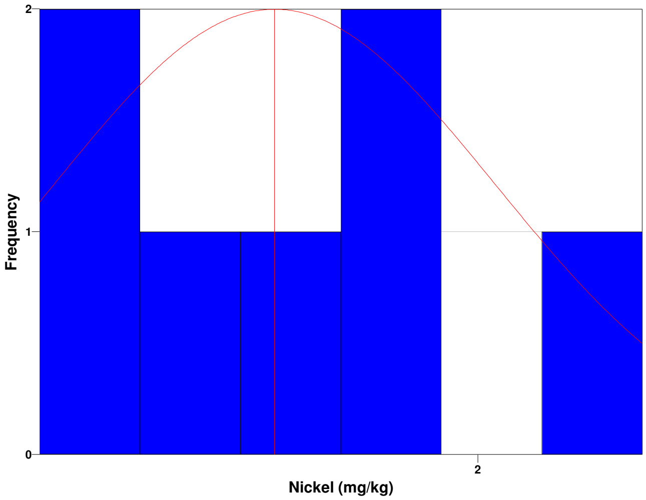
The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 1.2, do appear to follow a normal distribution at the 5% level of significance.

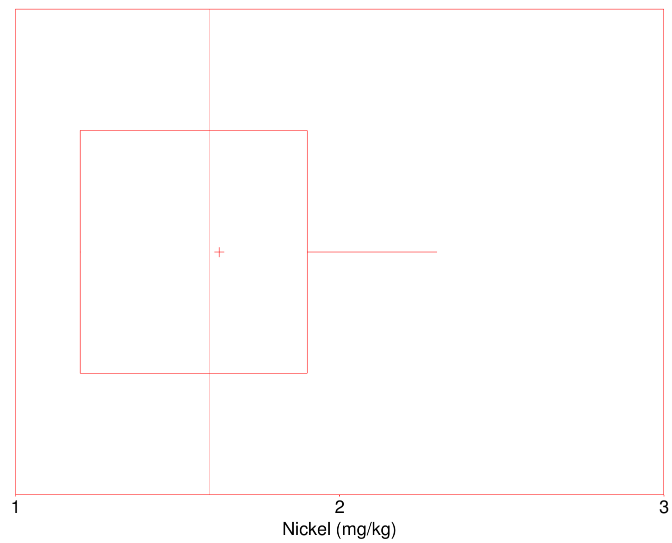
Data Plots for Nickel
Graphical displays of the data are shown below.

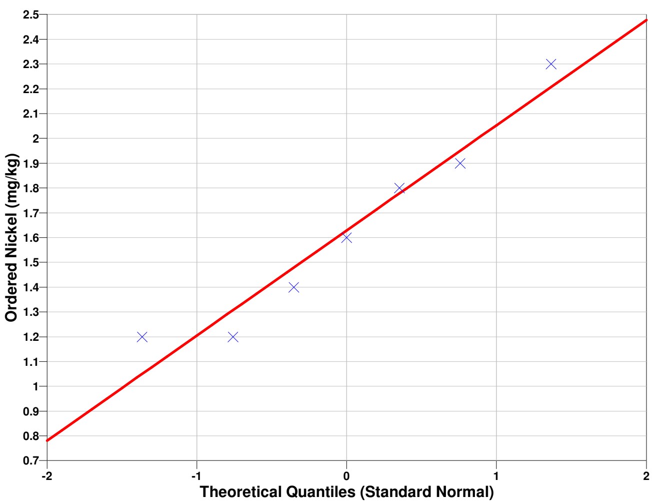
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Nickel
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9338
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that

assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	1.925
95% Non-Parametric (Chebyshev) UCL	2.292

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (1.925) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-186.28	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Toluene
The following data points were entered by the user for analysis.

Toluene (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00075	0.00075	0.00075	0.0016	0.0017	0.0017	0.0018			

SUMMARY STATISTICS for Toluene	
n	7
Min	0.00075
Max	0.0018
Range	0.00105
Mean	0.0012929
Median	0.0016
Variance	2.6119e-007
StdDev	0.00051107
Std Error	0.00019317
Skewness	-0.32432

Interquartile Range				0.00095				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00075	0.00075	0.00075	0.00075	0.0016	0.0017	0.0018	0.0018	0.0018

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Toluene	
Dixon Test Statistic	0
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.00075 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7386
Shapiro-Wilk 5% Critical Value	0.788

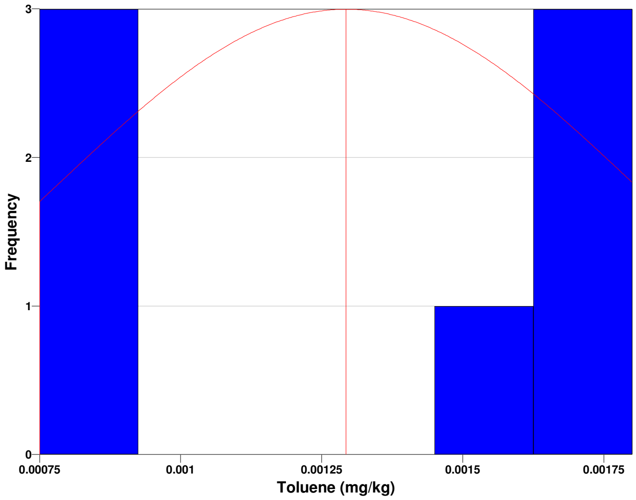
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.00075, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

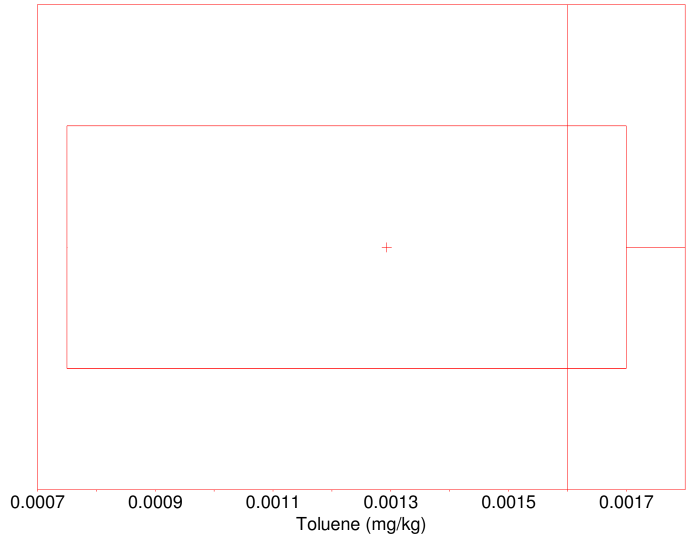
Data Plots for Toluene
Graphical displays of the data are shown below.

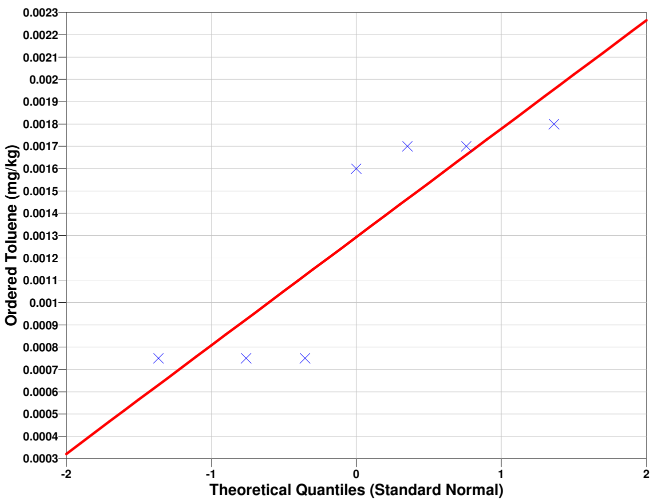
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Toluene

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7381
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that

assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.001668
95% Non-Parametric (Chebyshev) UCL	0.002135

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.002135) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.0354e+006	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Data Analysis for Vanadium
The following data points were entered by the user for analysis.

Vanadium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	4.4	4.5	4.6	5.1	5.3	5.5	7.9			

SUMMARY STATISTICS for Vanadium	
n	7
Min	4.4
Max	7.9

Range	3.5
Mean	5.3286
Median	5.1
Variance	1.4624
StdDev	1.2093
Std Error	0.45707
Skewness	2.0108
Interquartile Range	1

Percentiles

1%	5%	10%	25%	50%	75%	90%	95%	99%
4.4	4.4	4.4	4.5	5.1	5.5	7.9	7.9	7.9

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Vanadium	
Dixon Test Statistic	0.028571
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 4.4 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7768
Shapiro-Wilk 5% Critical Value	0.788

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 4.4, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

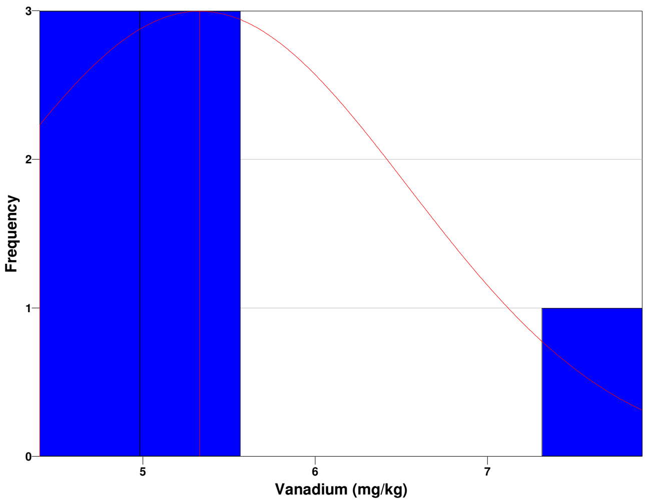
Data Plots for Vanadium
Graphical displays of the data are shown below.

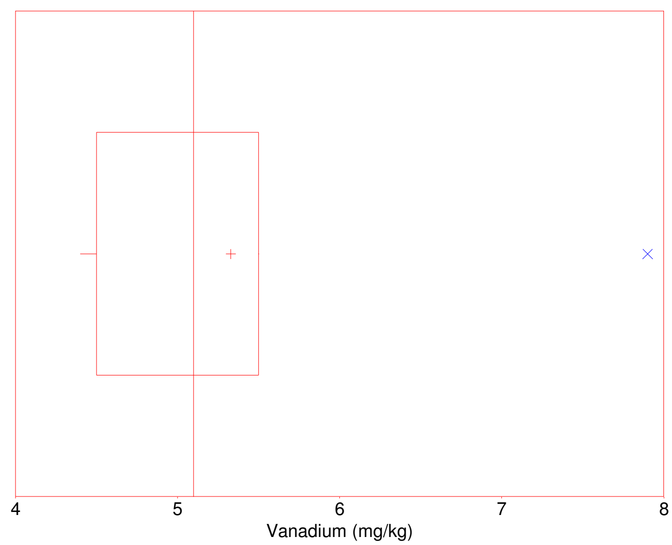
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

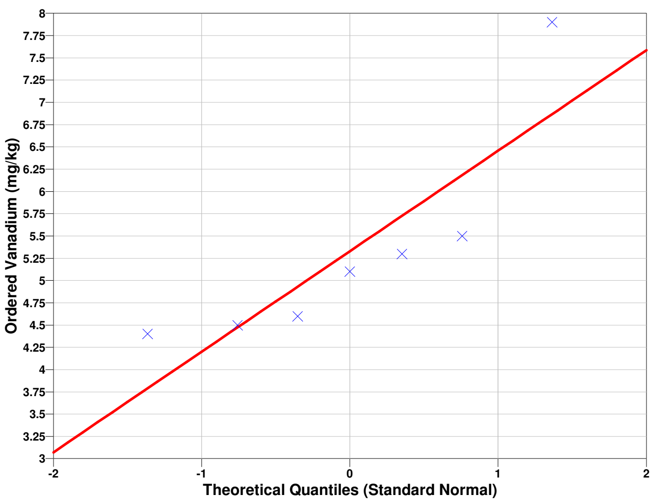
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box,

called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Vanadium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST

Shapiro-Wilk Test Statistic	0.7602
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	6.217
95% Non-Parametric (Chebyshev) UCL	7.321

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (7.321) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
7.2824	1.9432	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
0	6	Cannot Reject
Note: There may not be enough data to reject the null hypothesis (and conclude site is clean) with 95% confidence using the MARSSIM sign test.		

Data Analysis for Zinc
The following data points were entered by the user for analysis.

Zinc (mg/kg)

Rank	1	2	3	4	5	6	7	8	9	10
0	8.9	10.2	11.9	13.7	17.5	18.2	35.8			

SUMMARY STATISTICS for Zinc								
n	7							
Min	8.9							
Max	35.8							
Range	26.9							
Mean	16.6							
Median	13.7							
Variance	83.793							
StdDev	9.1539							
Std Error	3.4598							
Skewness	1.897							
Interquartile Range	8							
Percentiles								
1%	5%	10%	25%	50%	75%	90%	95%	99%
8.9	8.9	8.9	10.2	13.7	18.2	35.8	35.8	35.8

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Zinc	
Dixon Test Statistic	0.048327
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 8.9 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7948
Shapiro-Wilk 5% Critical Value	0.788

The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 8.9, do appear to follow a normal distribution at the 5% level of significance.

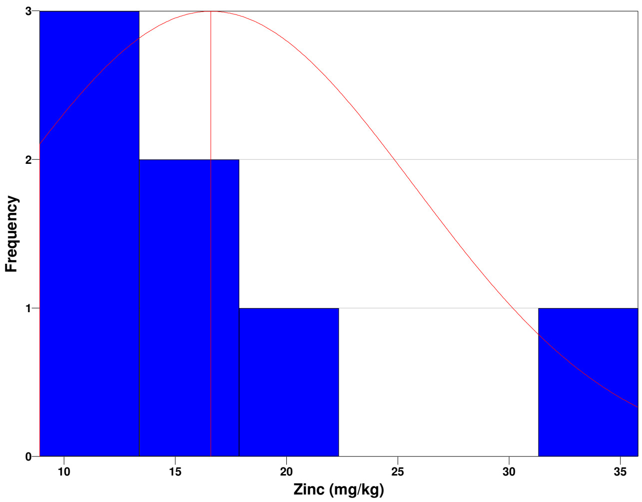
Data Plots for Zinc
Graphical displays of the data are shown below.

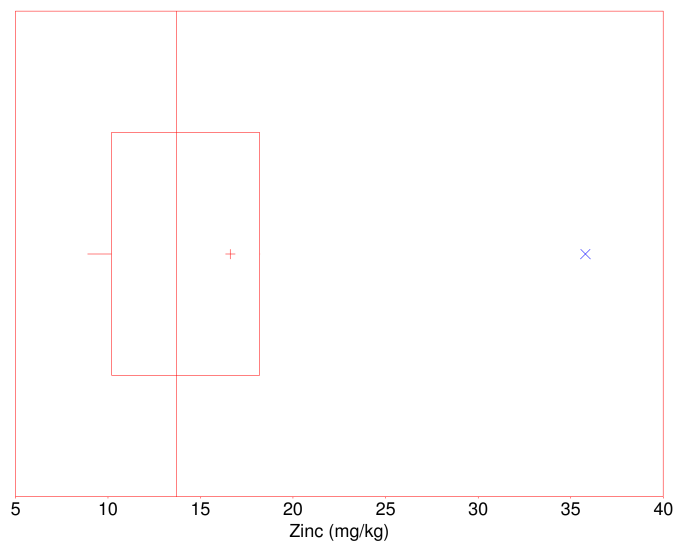
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

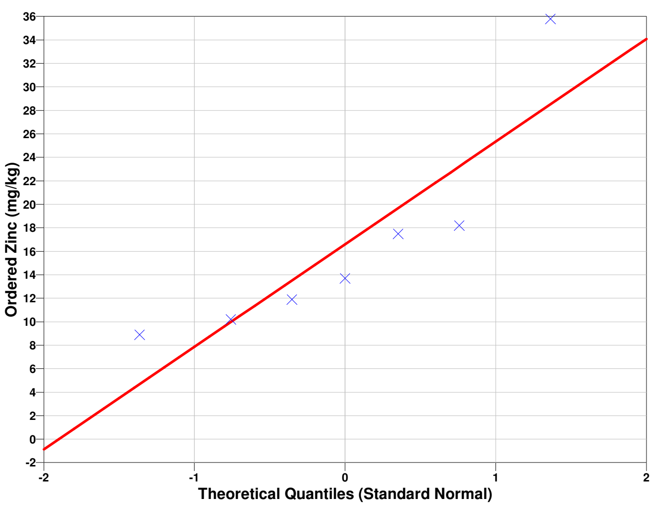
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Zinc
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7937
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	23.32
95% Non-Parametric (Chebyshev) UCL	31.68

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (31.68) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (120),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-29.886	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Appendix C

VSP Reports of Calculated Minimum Sample Quantity
Report 19

Area of Concern – 3

Minimum Sample Quantity Calculation for Surface Water using Human Health Benchmarks and Delta Method 1

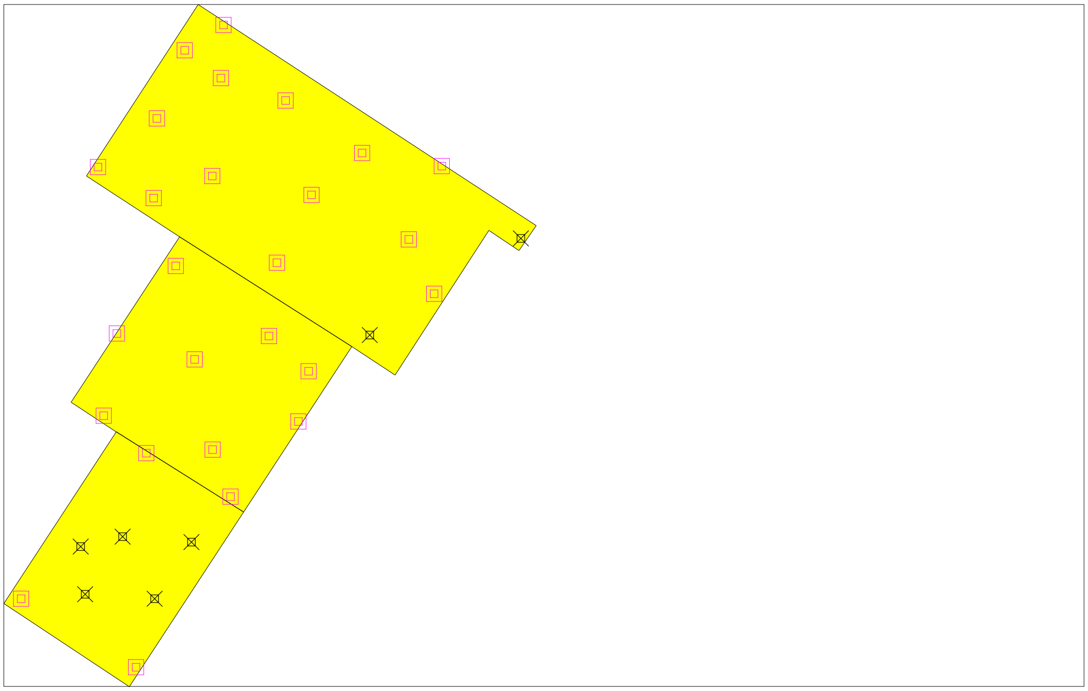
Random sampling locations for comparing a mean with a fixed threshold (parametric)

Summary
This report summarizes the sampling design, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design for Manganese, the driving analyte (the analyte which required the largest number of samples). A figure that shows sampling locations in the field and a table that lists sampling location coordinates are also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean to a fixed threshold
Type of Sampling Design	Parametric
Sample Placement (Location) in the Field	Simple random sampling
Working (Null) Hypothesis	The mean value at the site exceeds the threshold
Formula for calculating number of sampling locations	Student's t-test
Calculated total number of samples	33
Number of samples on map [a]	33
Number of selected sample areas [b]	1
Specified sampling area [c]	606637.01 m^2
Total cost of sampling [d]	$17,500.00

[a] This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[d] Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.



Area: Area 1					
X Coord	**Y Coord**	**Label**	**Value**	**Type**	**Historical**
680108.0130	3083101.3520	J-57SD		Manual	T
680413.8310	3083297.0130	J-58SD		Manual	T
679530.9430	3082575.4480	G-36SD		Manual	T
679606.6840	3082692.3830	G-37SD		Manual	T
679671.3170	3082565.9250	G-46SD		Manual	T
679745.9820	3082681.3860	G-47SD		Manual	T
679521.7790	3082672.0220	J-54SD		Manual	T
679788.6093	3083423.3855		0	Adaptive-Fill	
679752.8750	3083051.4414		0	Adaptive-Fill	
679810.9787	3083730.2665		0	Adaptive-Fill	
680092.1416	3083470.1986		0	Adaptive-Fill	
679919.5848	3083247.6207		0	Adaptive-Fill	
679962.7386	3082926.0427		0	Adaptive-Fill	
679568.1178	3082937.5390		0	Adaptive-Fill	
679556.7709	3083441.6331		0	Adaptive-Fill	
679714.4045	3083241.0250		0	Adaptive-Fill	
680186.8863	3083295.3453		0	Adaptive-Fill	
679937.2658	3083576.5325		0	Adaptive-Fill	
679788.7762	3082868.6995		0	Adaptive-Fill	
679594.6563	3083104.1123		0	Adaptive-Fill	
679675.8107	3083540.6516		0	Adaptive-Fill	
679633.9393	3082427.4227		0	Adaptive-Fill	

680253.7019	3083444.0194		0	Adaptive-Fill	
679989.8046	3083385.3358		0	Adaptive-Fill	
679401.0145	3082566.3322		0	Adaptive-Fill	
679669.7004	3083378.5438		0	Adaptive-Fill	
680238.4010	3083184.8908		0	Adaptive-Fill	
679903.4539	3083098.8152		0	Adaptive-Fill	
679654.9014	3082861.2233		0	Adaptive-Fill	
679825.1954	3082773.2944		0	Adaptive-Fill	
679983.5568	3083027.9852		0	Adaptive-Fill	
679806.0916	3083622.4994		0	Adaptive-Fill	
679732.6045	3083678.6403		0	Adaptive-Fill	

Primary Sampling Objective
The primary purpose of sampling at this site is to compare a mean value of a site with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the mean value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the mean value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative hypothesis, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach
A parametric random sampling approach was used to determine the number of samples and to specify sampling locations. A parametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that parametric assumptions are reasonable. These assumptions will be examined in post-sampling data analysis.

Both parametric and non-parametric approaches rely on assumptions about the population. However, non-parametric approaches typically require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than the number of samples required by non-parametric approaches.

Locating the sample points randomly provides data that are separated by many distances, whereas systematic samples are all equidistant apart. Therefore, random sampling provides more information about the spatial structure of the potential contamination than systematic sampling does. As with systematic sampling, random sampling also provides information regarding the mean value, but there is the possibility that areas of the site will not be represented with the same frequency as if uniform grid sampling were performed.

Number of Total Samples: Calculation Equation and Inputs
The equation used to calculate the number of samples is based on a Student's t-test. For this site, the null hypothesis is rejected in favor of the alternative hypothesis if the sample mean is sufficiently smaller than the threshold. The number of samples to collect is calculated so that 1) there will be a high probability ($1-\beta$) of rejecting the null hypothesis if the alternative hypothesis is true and 2) a low probability (α) of rejecting the null hypothesis if the null hypothesis is true.

The formula used to calculate the number of samples is:

$$n = \frac{S^2}{\Delta^2}\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2 + 0.5Z_{1-\alpha}^2$$

where
n is the number of samples,
S is the estimated standard deviation of the measured values including analytical error,
Δ is the width of the gray region,
α is the acceptable probability of incorrectly concluding the site mean is less than the threshold,
β is the acceptable probability of incorrectly concluding the site mean exceeds the threshold,
$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is $1-\alpha$,
$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is $1-\beta$.

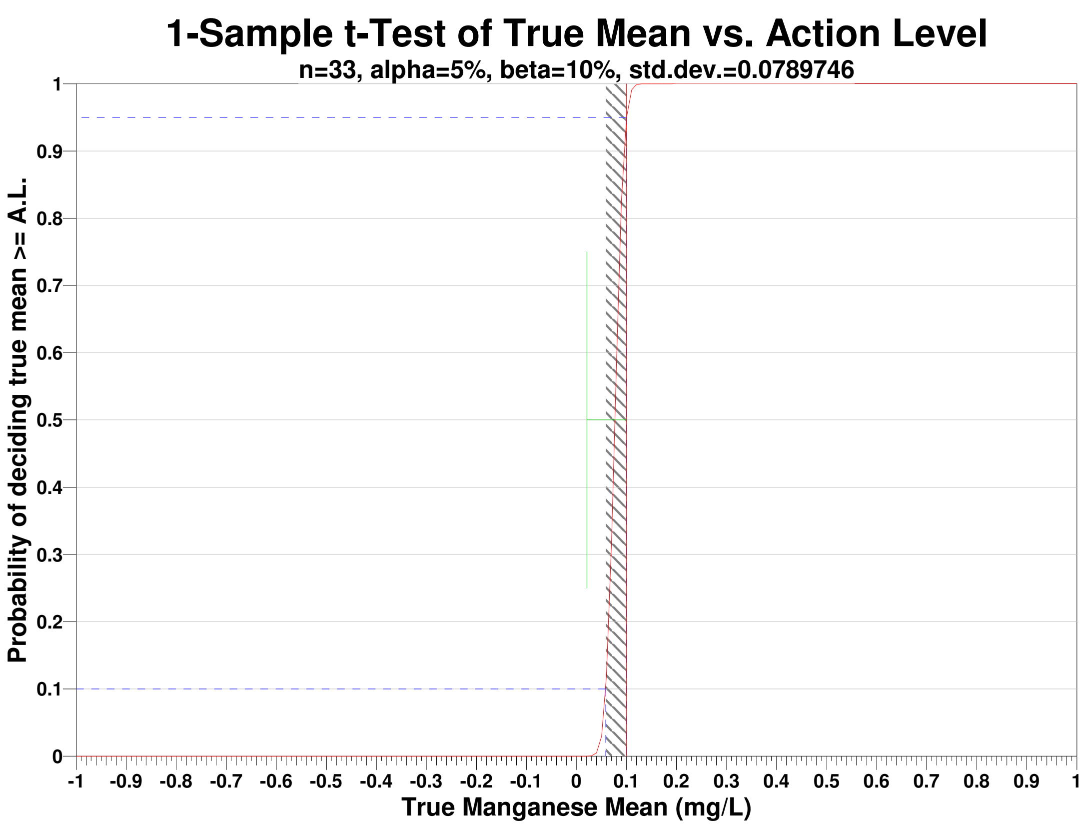
The values of these inputs that result in the calculated number of sampling locations are:

Analyte	n	Parameter					
		S	Δ	α	β	$Z_{1-\alpha}$ [a]	$Z_{1-\beta}$ [b]
00_Additional_Sample	2	0.1 mg/L	10 mg/L	0.05	0.1	1.64485	1.28155
Antimony	2	0.00124531 mg/L	0.637039 mg/L	0.05	0.1	1.64485	1.28155
Chromium_ Hexavalent	2	0.00612178 mg/L	2.20914 mg/L	0.05	0.1	1.64485	1.28155
Lead	2	0.0028689 mg/L	0.0124357 mg/L	0.05	0.1	1.64485	1.28155
Manganese	33	0.0789746 mg/L	0.0414571 mg/L	0.05	0.1	1.64485	1.28155
Zinc	2	0.0207353 mg/L	25.9702 mg/L	0.05	0.1	1.64485	1.28155

[a] This value is automatically calculated by VSP based upon the user defined value of α.
[b] This value is automatically calculated by VSP based upon the user defined value of β.

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000) for Manganese, the driving analyte. It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true mean values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at 1-α on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at 1-α. If any of the inputs change, the number of samples that result in the correct curve changes.



Statistical Assumptions
The assumptions associated with the formulas for computing the number of samples are:

1. the sample mean is normally distributed (this happens if the data are roughly symmetric or the sample size is more than 30; for extremely skewed data sets, additional samples may be required for the sample mean to be normally distributed),
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected randomly.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the sample locations were selected using a random process.

Sensitivity Analysis
The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that μ > action level and alpha (%), probability of mistakenly concluding that μ < action level. The following table shows the results of this analysis.

Number of Samples							
AL=0.1		**α=5**		**α=10**		**α=15**	
		s=0.157949	**s=0.0789746**	**s=0.157949**	**s=0.0789746**	**s=0.157949**	**s=0.0789746**
LBGR=90	**β=5**	2702	677	2138	535	1795	449
	β=10	2138	536	1640	411	1342	336
	β=15	1795	450	1342	336	1073	269
LBGR=80	**β=5**	677	171	535	135	449	113
	β=10	536	135	411	104	336	85
	β=15	450	114	336	85	269	68
LBGR=70	**β=5**	302	77	239	61	200	51
	β=10	239	61	183	47	150	38
	β=15	201	52	150	39	120	31

s = Standard Deviation
LBGR = Lower Bound of Gray Region (% of Action Level)
β = Beta (%), Probability of mistakenly concluding that μ > action level
α = Alpha (%), Probability of mistakenly concluding that μ < action level
AL = Action Level (Threshold)

Cost of Sampling
The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that are based on the number of samples collected and measured. Based on the numbers of samples determined above, the estimated total cost of sampling and analysis at this site is $17,500.00, which averages out to a per sample cost of $530.30. The following table summarizes the inputs and resulting cost estimates.

COST INFORMATION			
Cost Details	**Per Analysis**	**Per Sample**	**33 Samples**
Field collection costs		$100.00	$3,300.00
Analytical costs	$400.00	$400.00	$13,200.00
Sum of Field & Analytical costs		**$500.00**	**$16,500.00**
Fixed planning and validation costs			$1,000.00
Total cost			**$17,500.00**

Data Analysis for 00_Additional_Sample
The following data points were entered by the user for analysis.

00_Additional_Sample (mg/L)

Rank	1	2	3	4	5	6	7	8	9	10
0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0				

SUMMARY STATISTICS for 00_Additional_Sample								
n	26							
Min	0							
Max	0							
Range	0							
Mean	0							
Median	0							
Variance	0							
StdDev	0							
Std Error	0							
Skewness	-1.#IND							
Interquartile Range	0							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0	0	0	0	0	0	0	0	0

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for 00_Additional_Sample			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	-1.#IO	-1	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0
Shapiro-Wilk 5% Critical Value	0.881

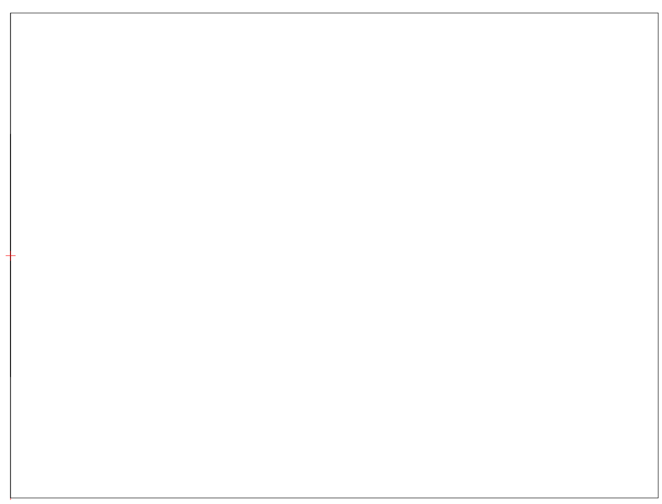
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

Data Plots for 00_Additional_Sample
Graphical displays of the data are shown below.

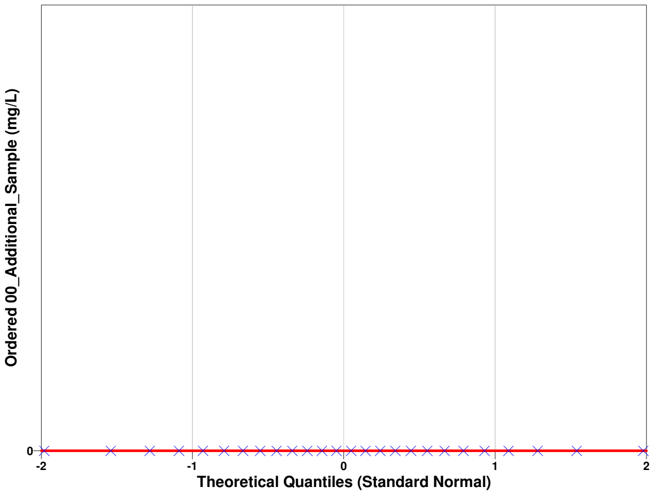
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.



00_Additional_Sample (mg/L)



For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for 00_Additional_Sample
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0
Shapiro-Wilk 5% Critical Value	0.92

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0
95% Non-Parametric (Chebyshev) UCL	0

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=26 data,
AL is the action level or threshold (0.1),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=25 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.#IND	1.7081	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
-1	-1	Reject

Data Analysis for Antimony
The following data points were entered by the user for analysis.

Antimony (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00135	0.00135	0.002425	0.0035	0.0038	0.0041	0.0042			

SUMMARY STATISTICS for Antimony								
n	7							
Min	0.00135							
Max	0.0042							
Range	0.00285							
Mean	0.0029607							
Median	0.0035							
Variance	1.5508e-006							
StdDev	0.0012453							
Std Error	0.00047068							
Skewness	-0.52935							
Interquartile Range	0.00275							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00135	0.00135	0.00135	0.00135	0.0035	0.0041	0.0042	0.0042	0.0042

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible

explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Antimony	
Dixon Test Statistic	0
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.00135 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8641
Shapiro-Wilk 5% Critical Value	0.788

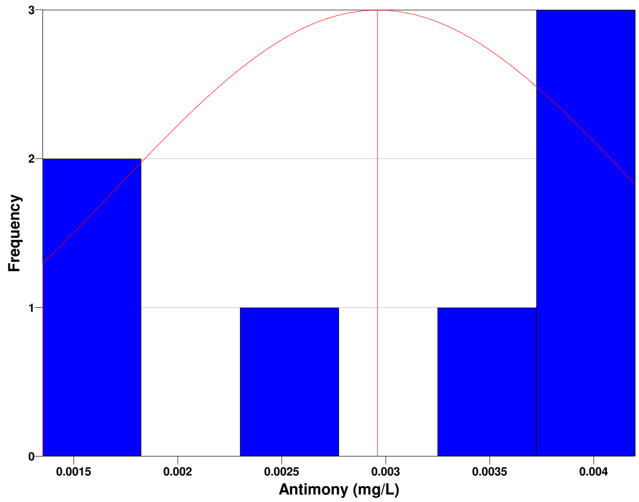
The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.00135, do appear to follow a normal distribution at the 5% level of significance.

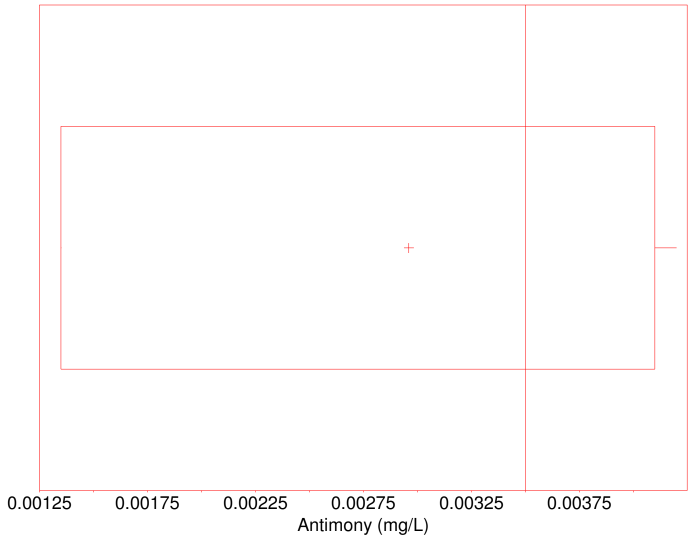
Data Plots for Antimony
Graphical displays of the data are shown below.

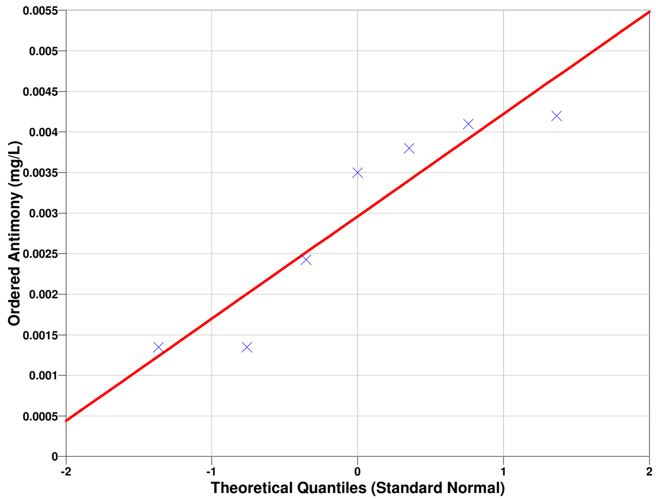
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Antimony

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8441
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.003875

95% Non-Parametric (Chebyshev) UCL	0.005012

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0.003875) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (0.1),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1353.4	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Chromium_ Hexavalent
The following data points were entered by the user for analysis.

Chromium_ Hexavalent (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.002	0.002	0.002	0.005	0.006	0.015	0.016			

SUMMARY STATISTICS for Chromium_ Hexavalent								
n	7							
Min	0.002							
Max	0.016							
Range	0.014							
Mean	0.0068571							
Median	0.005							
Variance	3.7476e-005							
StdDev	0.0061218							
Std Error	0.0023138							
Skewness	0.96965							
Interquartile Range	0.013							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**

0.002	0.002	0.002	0.002	0.005	0.015	0.016	0.016	0.016

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Chromium_ Hexavalent	
Dixon Test Statistic	0
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.002 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8223
Shapiro-Wilk 5% Critical Value	0.788

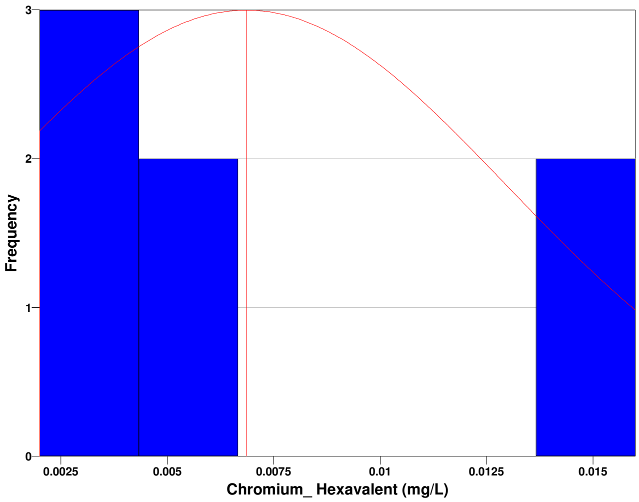
The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.002, do appear to follow a normal distribution at the 5% level of significance.

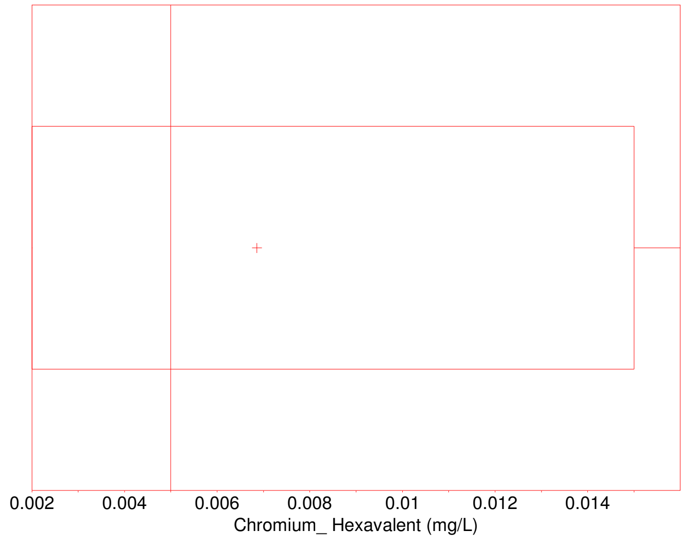
Data Plots for Chromium_ Hexavalent
Graphical displays of the data are shown below.

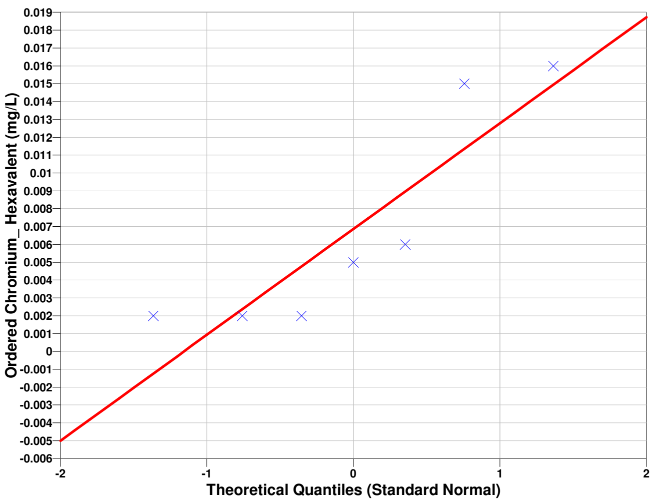
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Chromium_ Hexavalent
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7781
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.01135

95% Non-Parametric (Chebyshev) UCL	0.01694

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.01694) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (0.1),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-954.76	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Data Analysis for Lead
The following data points were entered by the user for analysis.

Lead (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0014	0.00235	0.0032	0.004	0.0048	0.0053	0.0102			

SUMMARY STATISTICS for Lead	
n	7
Min	0.0014
Max	0.0102
Range	0.0088
Mean	0.0044643
Median	0.004
Variance	8.2306e-006

StdDev				0.0028689				
Std Error				0.0010843				
Skewness				1.4721				
Interquartile Range				0.00295				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0014	0.0014	0.0014	0.00235	0.004	0.0053	0.0102	0.0102	0.0102

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Lead	
Dixon Test Statistic	0.10795
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.0014 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8477
Shapiro-Wilk 5% Critical Value	0.788

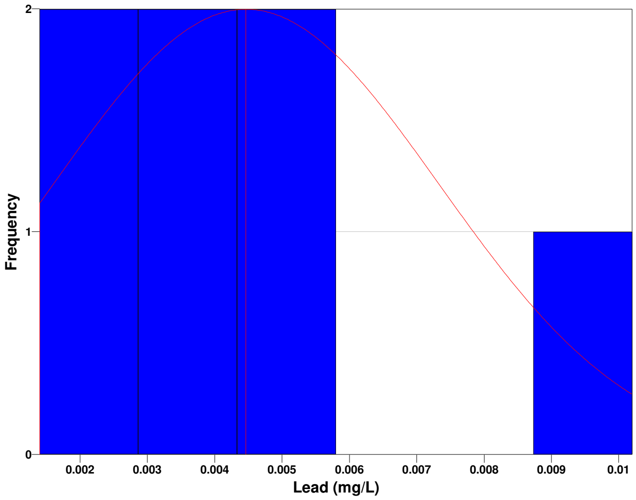
The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.0014, do appear to follow a normal distribution at the 5% level of significance.

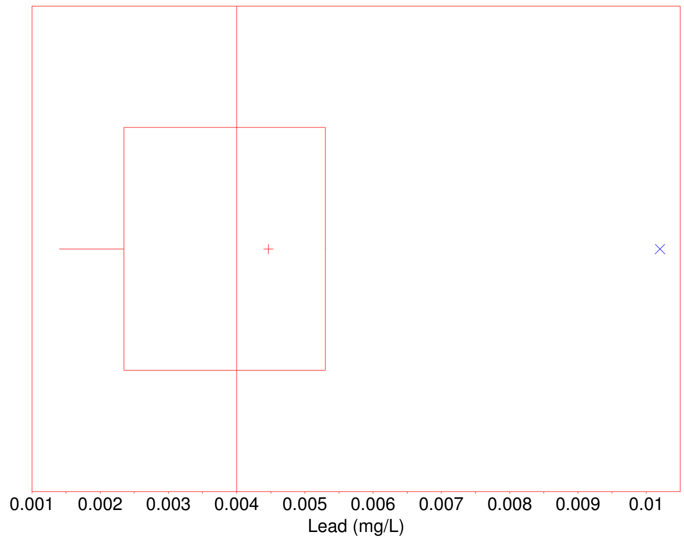
Data Plots for Lead
Graphical displays of the data are shown below.

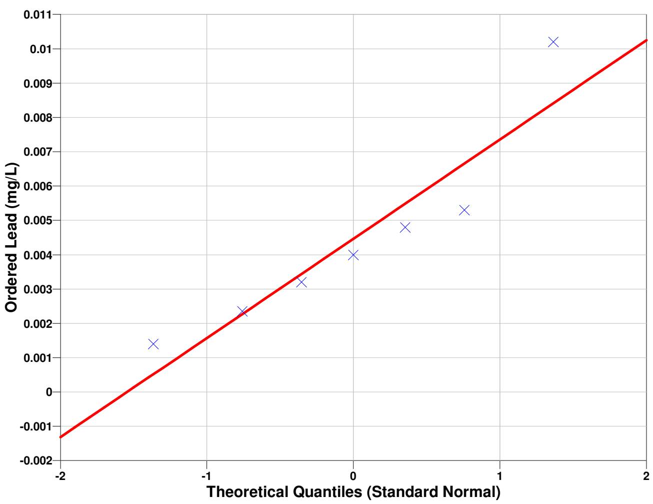
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Lead
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.883
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that

assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.006571
95% Non-Parametric (Chebyshev) UCL	0.009191

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0.006571) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (0.1),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-11.468	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Manganese
The following data points were entered by the user for analysis.

Manganese (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0069	0.008	0.014	0.0145	0.0214	0.151	0.194			

SUMMARY STATISTICS for Manganese	
n	7
Min	0.0069
Max	0.194
Range	0.1871
Mean	0.058543
Median	0.0145
Variance	0.006237
StdDev	0.078975
Std Error	0.02985
Skewness	1.3188

Interquartile Range				0.143				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0069	0.0069	0.0069	0.008	0.0145	0.151	0.194	0.194	0.194

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Manganese	
Dixon Test Statistic	0.0058792
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.0069 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7337
Shapiro-Wilk 5% Critical Value	0.788

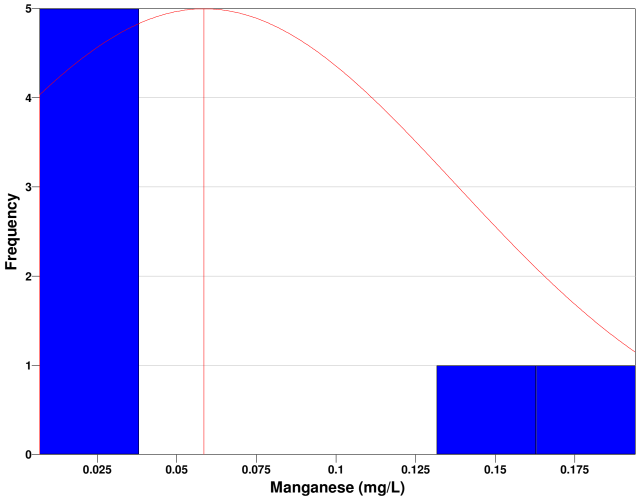
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.0069, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

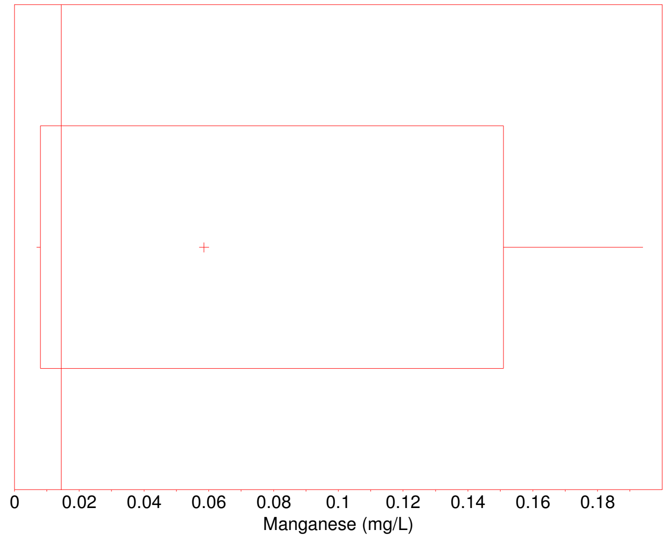
Data Plots for Manganese
Graphical displays of the data are shown below.

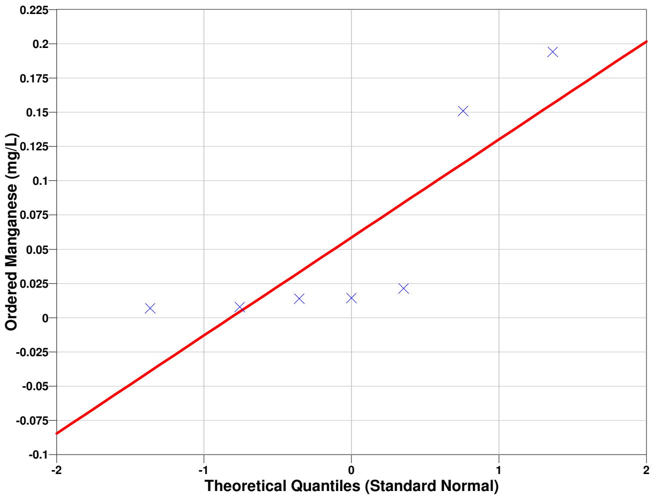
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Manganese
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6927
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that

assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.1165
95% Non-Parametric (Chebyshev) UCL	0.1887

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.1887) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (0.1),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.3889	1.9432	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
5	6	Cannot Reject
Note: There may not be enough data to reject the null hypothesis (and conclude site is clean) with 95% confidence using the MARSSIM sign test.		

Data Analysis for Zinc
The following data points were entered by the user for analysis.

Zinc (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0184	0.0185	0.0203	0.0217	0.0228	0.0309	0.0758			

SUMMARY STATISTICS for Zinc	
n	7

Min				0.0184				
Max				0.0758				
Range				0.0574				
Mean				0.029771				
Median				0.0217				
Variance				0.00042995				
StdDev				0.020735				
Std Error				0.0078372				
Skewness				2.4315				
Interquartile Range				0.0124				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0184	0.0184	0.0184	0.0185	0.0217	0.0309	0.0758	0.0758	0.0758

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Zinc	
Dixon Test Statistic	0.0017422
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.0184 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6561
Shapiro-Wilk 5% Critical Value	0.788

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.0184, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

Data Plots for Zinc
Graphical displays of the data are shown below.

The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over

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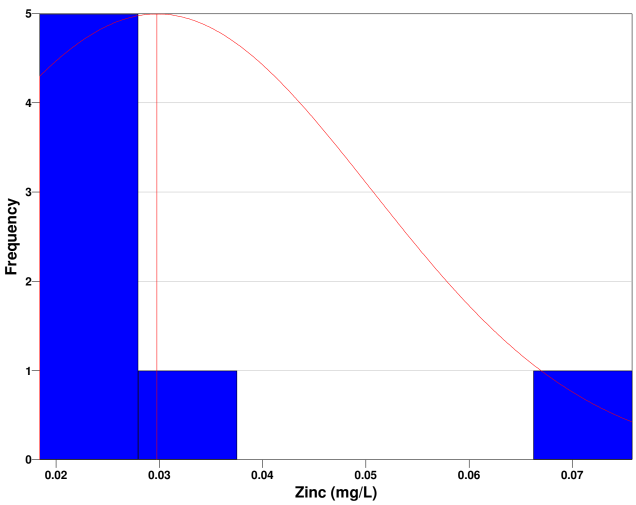
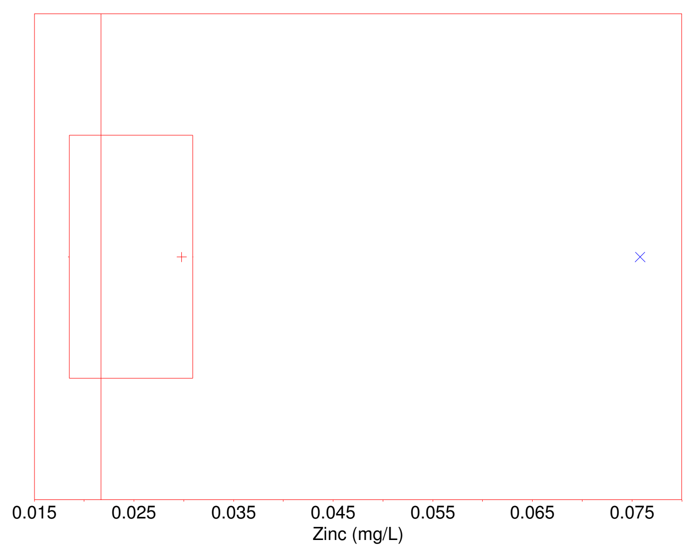
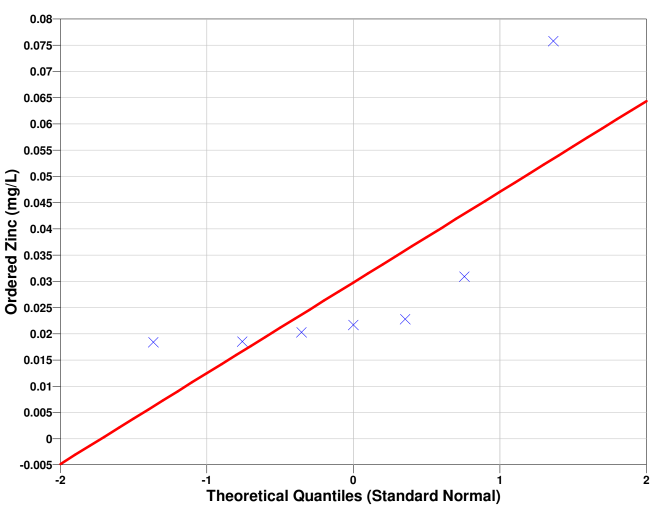






For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Zinc

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution.

The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6167
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.045
95% Non-Parametric (Chebyshev) UCL	0.06393

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.06393) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (0.1),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-3313.7	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Appendix C

VSP Reports of Calculated Minimum Sample Quantity
Report 20
Area of Concern – 3
Minimum Sample Quantity Calculation for Surface Water using Human Health Benchmarks and Delta Method 2

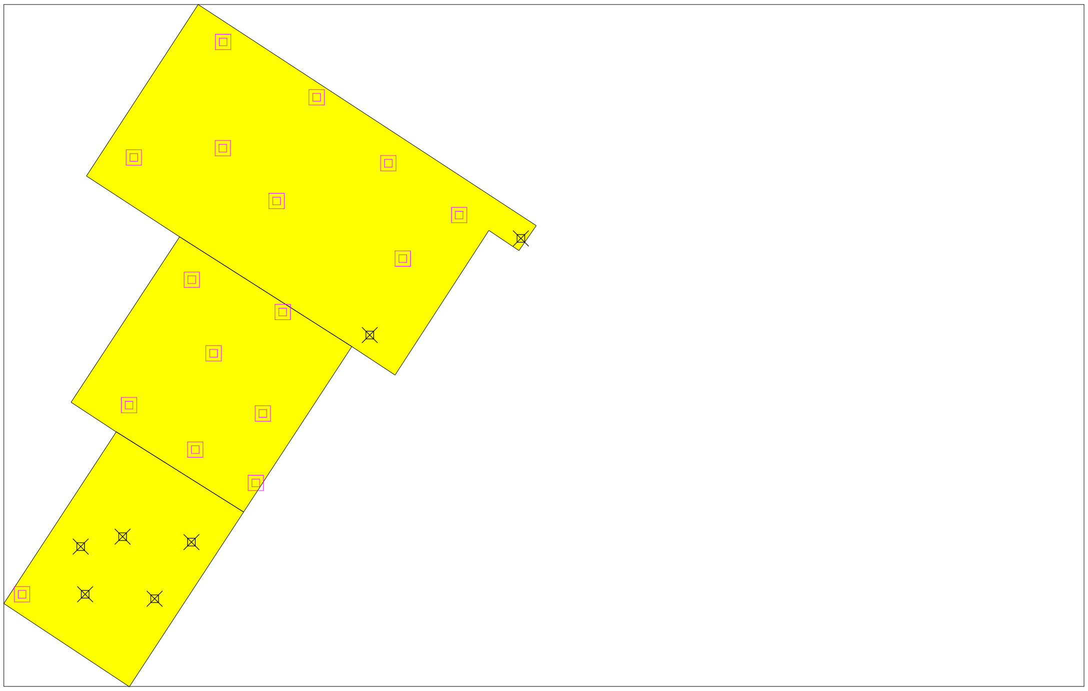
Random sampling locations for comparing a mean with a fixed threshold (parametric)

Summary
This report summarizes the sampling design, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design for Manganese, the driving analyte (the analyte which required the largest number of samples). A figure that shows sampling locations in the field and a table that lists sampling location coordinates are also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean to a fixed threshold
Type of Sampling Design	Parametric
Sample Placement (Location) in the Field	Simple random sampling
Working (Null) Hypothesis	The mean value at the site exceeds the threshold
Formula for calculating number of sampling locations	Student's t-test
Calculated total number of samples	23
Number of samples on map [a]	23
Number of selected sample areas [b]	1
Specified sampling area [c]	606637.01 m^2
Total cost of sampling [d]	$12,500.00

[a] This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[d] Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.



Area: Area 1					
X Coord	Y Coord	Label	Value	Type	Historical
680108.0130	3083101.3520	J-57SD		Manual	T
680413.8310	3083297.0130	J-58SD		Manual	T
679530.9430	3082575.4480	G-36SD		Manual	T
679606.6840	3082692.3830	G-37SD		Manual	T
679671.3170	3082565.9250	G-46SD		Manual	T
679745.9820	3082681.3860	G-47SD		Manual	T
679521.7790	3082672.0220	J-54SD		Manual	T
680145.4591	3083449.3186		0	Adaptive-Fill	
679746.6513	3083213.1636		0	Adaptive-Fill	
679810.2063	3083695.5038		0	Adaptive-Fill	
679629.6833	3083461.5431		0	Adaptive-Fill	
679619.5102	3082959.1442		0	Adaptive-Fill	
679890.8557	3082941.8411		0	Adaptive-Fill	
679918.8840	3083372.8308		0	Adaptive-Fill	
679999.8994	3083583.4145		0	Adaptive-Fill	
679931.4002	3083147.9447		0	Adaptive-Fill	
680174.4863	3083256.0617		0	Adaptive-Fill	
679790.7767	3083063.9652		0	Adaptive-Fill	
679754.1513	3082868.6340		0	Adaptive-Fill	
679876.5238	3082801.1067		0	Adaptive-Fill	
680288.5792	3083344.1422		0	Adaptive-Fill	
679809.5539	3083480.1541		0	Adaptive-Fill	

679402.5566	3082575.4501		0	Adaptive-Fill	

Primary Sampling Objective
The primary purpose of sampling at this site is to compare a mean value of a site with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the mean value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the mean value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative hypothesis, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach
A parametric random sampling approach was used to determine the number of samples and to specify sampling locations. A parametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that parametric assumptions are reasonable. These assumptions will be examined in post-sampling data analysis.

Both parametric and non-parametric approaches rely on assumptions about the population. However, non-parametric approaches typically require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than the number of samples required by non-parametric approaches.

Locating the sample points randomly provides data that are separated by many distances, whereas systematic samples are all equidistant apart. Therefore, random sampling provides more information about the spatial structure of the potential contamination than systematic sampling does. As with systematic sampling, random sampling also provides information regarding the mean value, but there is the possibility that areas of the site will not be represented with the same frequency as if uniform grid sampling were performed.

Number of Total Samples: Calculation Equation and Inputs
The equation used to calculate the number of samples is based on a Student's t-test. For this site, the null hypothesis is rejected in favor of the alternative hypothesis if the sample mean is sufficiently smaller than the threshold. The number of samples to collect is calculated so that 1) there will be a high probability (1-β) of rejecting the null hypothesis if the alternative hypothesis is true and 2) a low probability (α) of rejecting the null hypothesis if the null hypothesis is true.

The formula used to calculate the number of samples is:

$$n = \frac{S^2}{\Delta^2}\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2 + 0.5Z_{1-\alpha}^2$$

where
n is the number of samples,
S is the estimated standard deviation of the measured values including analytical error,
Δ is the width of the gray region,
α is the acceptable probability of incorrectly concluding the site mean is less than the threshold,
β is the acceptable probability of incorrectly concluding the site mean exceeds the threshold,
$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is 1-α,
$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is 1-β.

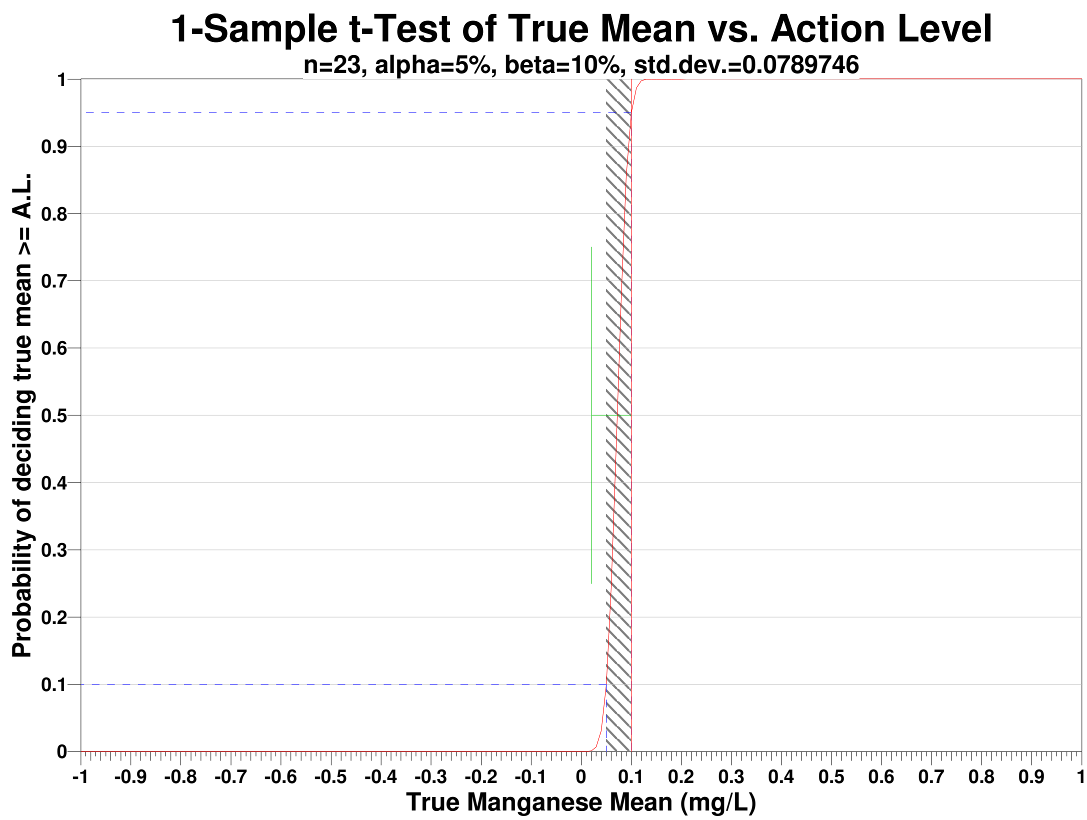
The values of these inputs that result in the calculated number of sampling locations are:

Analyte	n	Parameter					
		S	Δ	α	β	$Z_{1-\alpha}$ [a]	$Z_{1-\beta}$ [b]
00_Additional_Sample	2	0.1 mg/L	10 mg/L	0.05	0.1	1.64485	1.28155
Antimony	2	0.00124531 mg/L	0.32 mg/L	0.05	0.1	1.64485	1.28155
Chromium_ Hexavalent	2	0.00612178 mg/L	1.108 mg/L	0.05	0.1	1.64485	1.28155
Lead	3	0.0028689 mg/L	0.00845 mg/L	0.05	0.1	1.64485	1.28155
Manganese	23	0.0789746 mg/L	0.05 mg/L	0.05	0.1	1.64485	1.28155
Zinc	2	0.0207353 mg/L	13 mg/L	0.05	0.1	1.64485	1.28155

[a] This value is automatically calculated by VSP based upon the user defined value of α.
[b] This value is automatically calculated by VSP based upon the user defined value of β.

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000) for Manganese, the driving analyte. It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true mean values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at 1-α on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at 1-α. If any of the inputs change, the number of samples that result in the correct curve changes.



Statistical Assumptions
The assumptions associated with the formulas for computing the number of samples are:
1. the sample mean is normally distributed (this happens if the data are roughly symmetric or the sample size is more than 30; for extremely skewed data sets, additional samples may be required for the sample mean to be normally distributed),
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected randomly.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the sample locations were selected using a random process.

Sensitivity Analysis
The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that μ > action level and alpha (%), probability of mistakenly concluding that μ < action level. The following table shows the results of this analysis.

Number of Samples

AL=26		α=5		α=10		α=15	
		s=0.0414706	s=0.0207353	s=0.0414706	s=0.0207353	s=0.0414706	s=0.0207353
LBGR=90	β=5	188	48	149	38	125	32
	β=10	149	39	114	30	93	24
	β=15	125	33	94	24	75	20
LBGR=80	β=5	48	13	38	11	32	9
	β=10	39	11	30	8	24	7
	β=15	33	10	24	7	20	6
LBGR=70	β=5	23	7	18	5	15	4
	β=10	18	6	14	4	11	4
	β=15	16	5	12	4	9	3

s = Standard Deviation
LBGR = Lower Bound of Gray Region (% of Action Level)
β = Beta (%), Probability of mistakenly concluding that μ > action level
α = Alpha (%), Probability of mistakenly concluding that μ < action level
AL = Action Level (Threshold)

Cost of Sampling
The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that are based on the number of samples collected and measured. Based on the numbers of samples determined above, the estimated total cost of sampling and analysis at this site is $12,500.00, which averages out to a per sample cost of $543.48. The following table summarizes the inputs and resulting cost estimates.

COST INFORMATION			
Cost Details	**Per Analysis**	**Per Sample**	**23 Samples**
Field collection costs		$100.00	$2,300.00
Analytical costs	$400.00	$400.00	$9,200.00
Sum of Field & Analytical costs		**$500.00**	**$11,500.00**
Fixed planning and validation costs			$1,000.00
Total cost			**$12,500.00**

Data Analysis for 00_Additional_Sample
The following data points were entered by the user for analysis.

00_Additional_Sample (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0				

SUMMARY STATISTICS for 00_Additional_Sample	
n	16
Min	0
Max	0
Range	0

Mean				0				
Median				0				
Variance				0				
StdDev				0				
Std Error				0				
Skewness				-1.#IND				
Interquartile Range				0				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0	0	0	0	0	0	0	0	0

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for 00_Additional_Sample	
Dixon Test Statistic	0
Dixon 5% Critical Value	0

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	1.061e+292
Shapiro-Wilk 5% Critical Value	1.376e-313

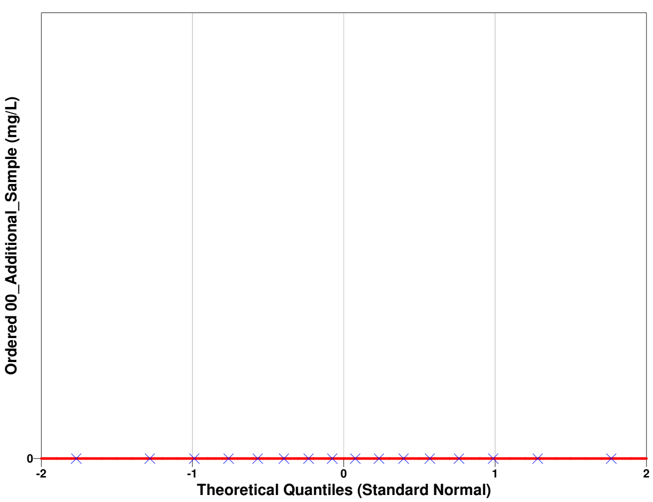
The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

Data Plots for 00_Additional_Sample
Graphical displays of the data are shown below.

The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.



For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for 00_Additional_Sample
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST

Shapiro-Wilk Test Statistic	0
Shapiro-Wilk 5% Critical Value	0.887

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0
95% Non-Parametric (Chebyshev) UCL	0

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=16 data,
AL is the action level or threshold (26),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=15 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.#IND	1.7531	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
-1	-1	Reject

Data Analysis for Antimony
The following data points were entered by the user for analysis.

Antimony (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

0	0.00135	0.00135	0.002425	0.0035	0.0038	0.0041	0.0042			

SUMMARY STATISTICS for Antimony								
n				7				
Min				0.00135				
Max				0.0042				
Range				0.00285				
Mean				0.0029607				
Median				0.0035				
Variance				1.5508e-006				
StdDev				0.0012453				
Std Error				0.00047068				
Skewness				-0.52935				
Interquartile Range				0.00275				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00135	0.00135	0.00135	0.00135	0.0035	0.0041	0.0042	0.0042	0.0042

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Antimony	
Dixon Test Statistic	0
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.00135 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8641
Shapiro-Wilk 5% Critical Value	0.788

The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.00135, do appear to follow a normal distribution at the 5% level of significance.

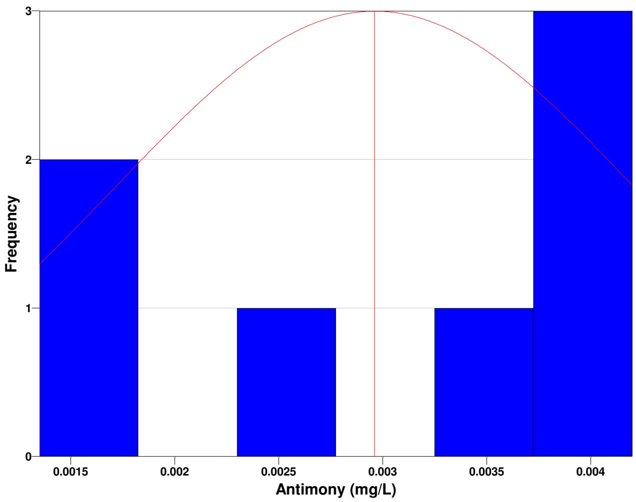
Data Plots for Antimony
Graphical displays of the data are shown below.

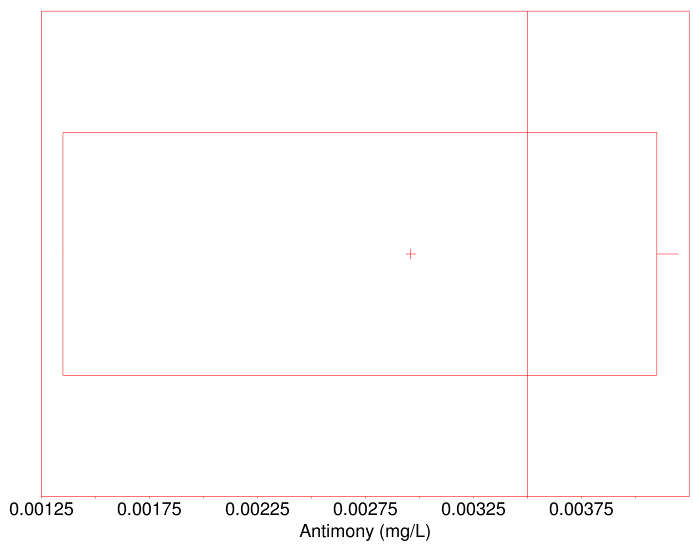
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

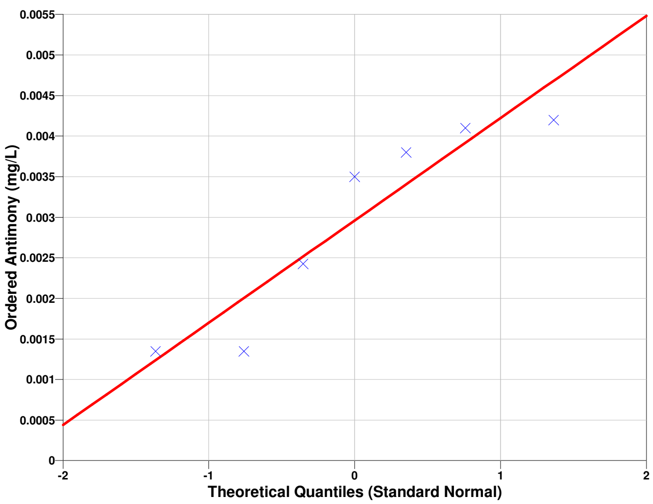
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Antimony
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.8441
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.003875
95% Non-Parametric (Chebyshev) UCL	0.005012

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0.003875) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (26),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1353.4	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Chromium_ Hexavalent
The following data points were entered by the user for analysis.

Chromium_ Hexavalent (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.002	0.002	0.002	0.005	0.006	0.015	0.016			

SUMMARY STATISTICS for Chromium_ Hexavalent

n	7
Min	0.002
Max	0.016
Range	0.014
Mean	0.0068571
Median	0.005
Variance	3.7476e-005
StdDev	0.0061218
Std Error	0.0023138
Skewness	0.96965
Interquartile Range	0.013

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.002	0.002	0.002	0.002	0.005	0.015	0.016	0.016	0.016

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Chromium_ Hexavalent	
Dixon Test Statistic	0
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.002 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8223
Shapiro-Wilk 5% Critical Value	0.788

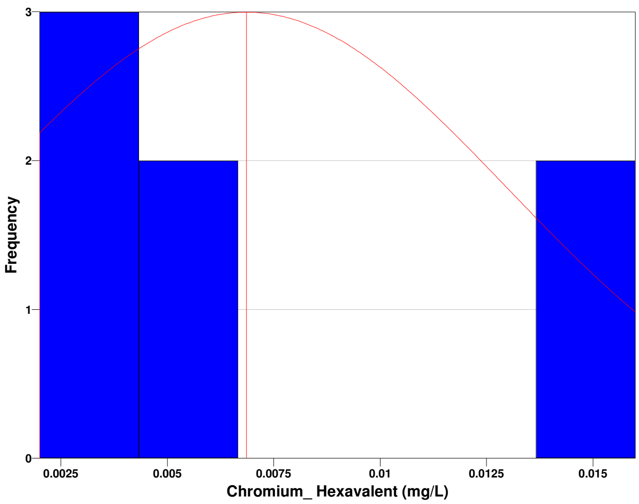
The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.002, do appear to follow a normal distribution at the 5% level of significance.

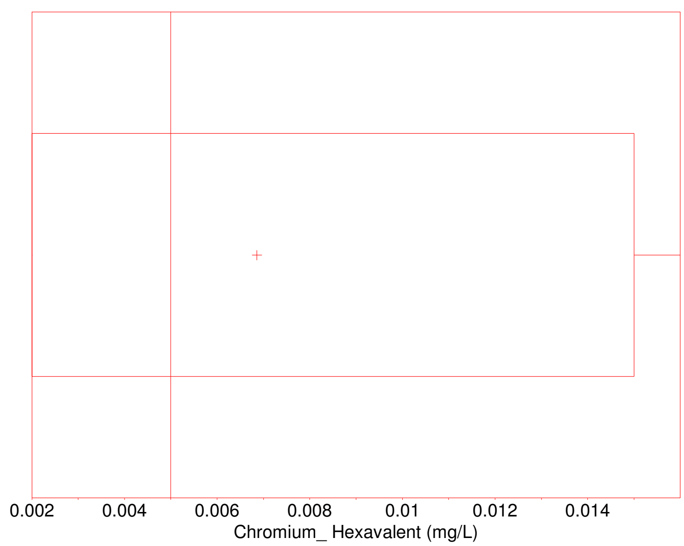
Data Plots for Chromium_ Hexavalent
Graphical displays of the data are shown below.

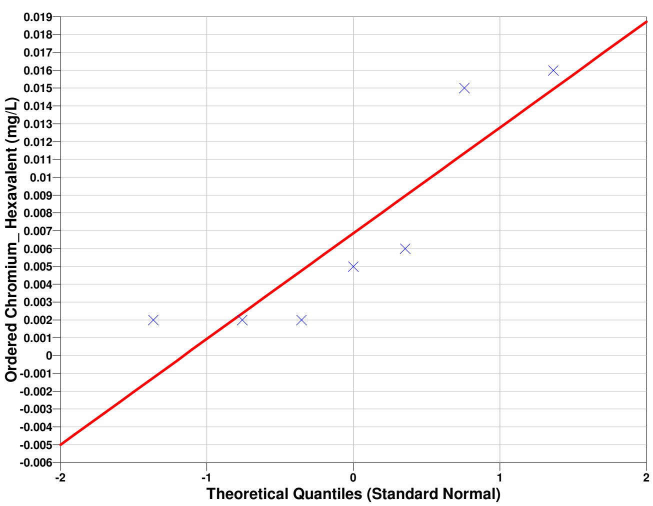
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Chromium_ Hexavalent

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST

Shapiro-Wilk Test Statistic	0.7781
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.01135
95% Non-Parametric (Chebyshev) UCL	0.01694

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.01694) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (26),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-954.76	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Data Analysis for Lead
The following data points were entered by the user for analysis.

Lead (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

0	0.0014	0.00235	0.0032	0.004	0.0048	0.0053	0.0102			

SUMMARY STATISTICS for Lead								
n	7							
Min	0.0014							
Max	0.0102							
Range	0.0088							
Mean	0.0044643							
Median	0.004							
Variance	8.2306e-006							
StdDev	0.0028689							
Std Error	0.0010843							
Skewness	1.4721							
Interquartile Range	0.00295							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0014	0.0014	0.0014	0.00235	0.004	0.0053	0.0102	0.0102	0.0102

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Lead	
Dixon Test Statistic	0.10795
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.0014 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8477
Shapiro-Wilk 5% Critical Value	0.788

The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.0014, do appear to follow a normal distribution at the 5% level of significance.

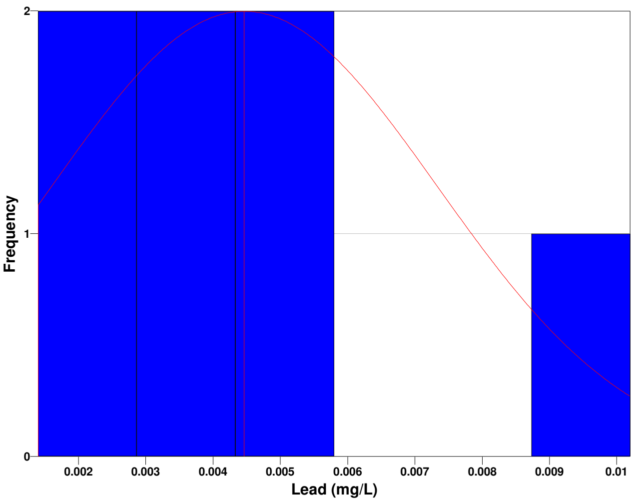
Data Plots for Lead
Graphical displays of the data are shown below.

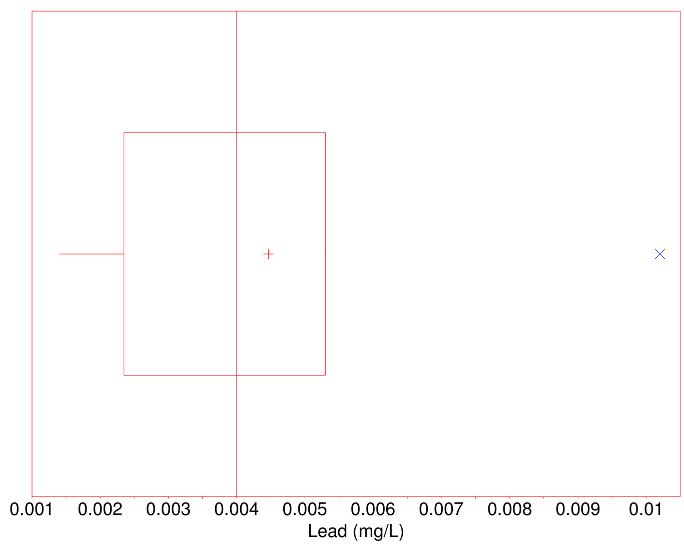
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

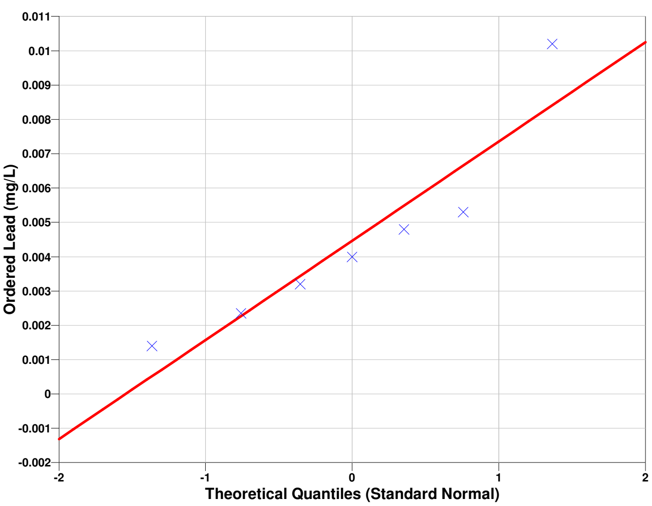
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Lead
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.883
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.006571
95% Non-Parametric (Chebyshev) UCL	0.009191

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0.006571) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (26),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-11.468	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Manganese
The following data points were entered by the user for analysis.

Manganese (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0069	0.008	0.014	0.0145	0.0214	0.151	0.194			

SUMMARY STATISTICS for Manganese

n				7				
Min				0.0069				
Max				0.194				
Range				0.1871				
Mean				0.058543				
Median				0.0145				
Variance				0.006237				
StdDev				0.078975				
Std Error				0.02985				
Skewness				1.3188				
Interquartile Range				0.143				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0069	0.0069	0.0069	0.008	0.0145	0.151	0.194	0.194	0.194

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Manganese	
Dixon Test Statistic	0.0058792
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.0069 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7337
Shapiro-Wilk 5% Critical Value	0.788

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.0069, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

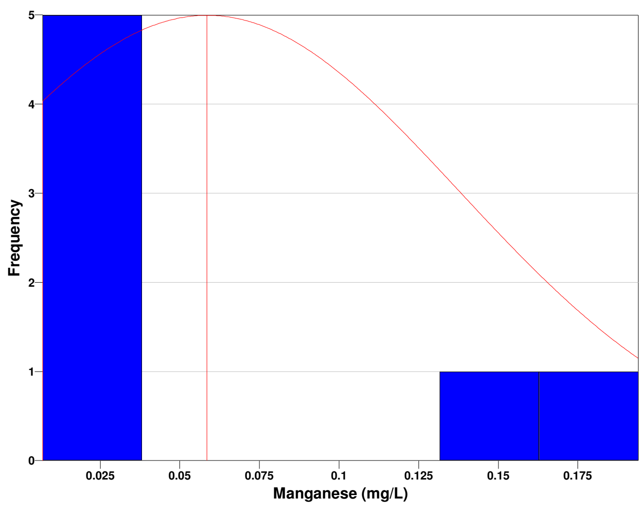
Data Plots for Manganese
Graphical displays of the data are shown below.

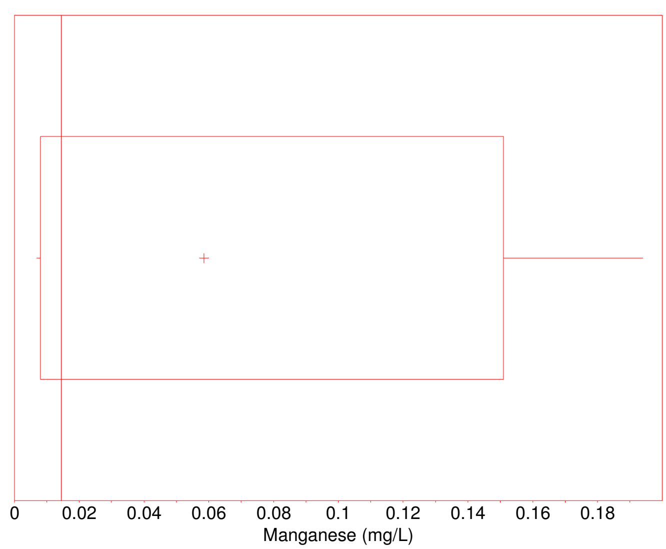
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each

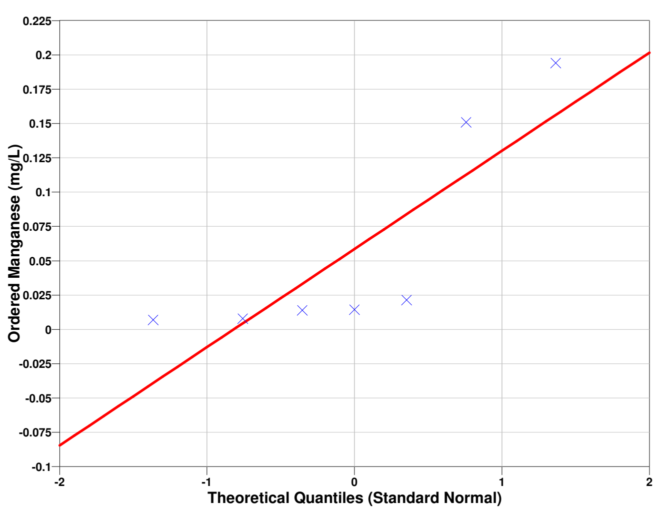
bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Manganese
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6927
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.1165
95% Non-Parametric (Chebyshev) UCL	0.1887

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.1887) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (26),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.3889	1.9432	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
5	6	Cannot Reject
Note: There may not be enough data to reject the null hypothesis (and conclude site is clean) with 95% confidence using the MARSSIM sign test.		

Data Analysis for Zinc
The following data points were entered by the user for analysis.

Zinc (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0184	0.0185	0.0203	0.0217	0.0228	0.0309	0.0758			

SUMMARY STATISTICS for Zinc								
n	7							
Min	0.0184							
Max	0.0758							
Range	0.0574							
Mean	0.029771							
Median	0.0217							
Variance	0.00042995							
StdDev	0.020735							
Std Error	0.0078372							
Skewness	2.4315							
Interquartile Range	0.0124							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0184	0.0184	0.0184	0.0185	0.0217	0.0309	0.0758	0.0758	0.0758

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Zinc	
Dixon Test Statistic	0.0017422
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.0184 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6561

Shapiro-Wilk 5% Critical Value	0.788

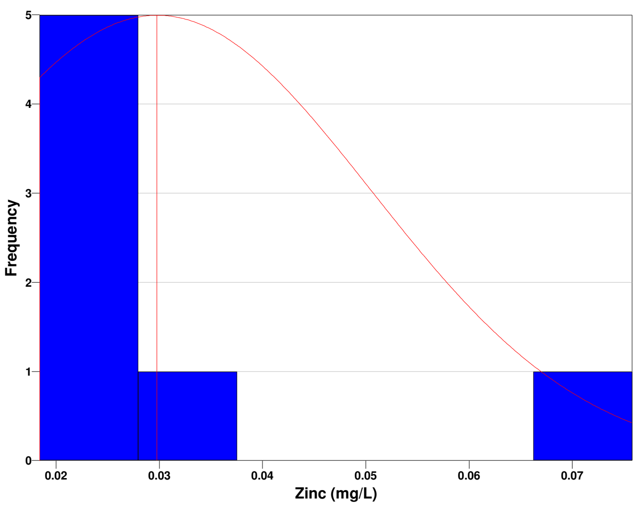
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.0184, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

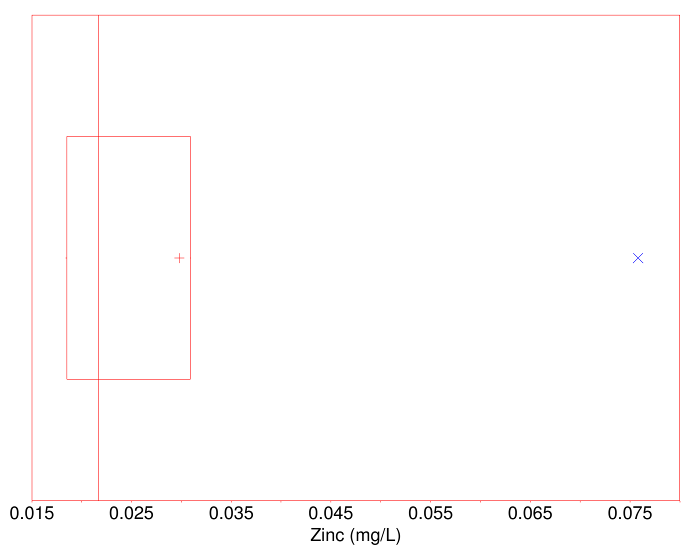
Data Plots for Zinc
Graphical displays of the data are shown below.

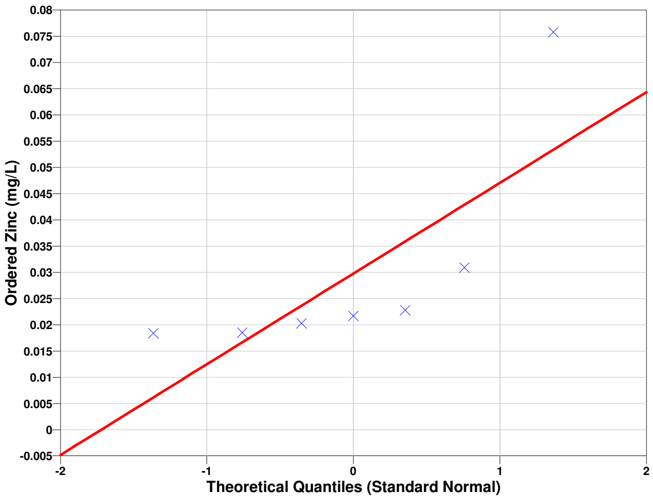
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Zinc
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6167
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.045
95% Non-Parametric (Chebyshev) UCL	0.06393

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.06393) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (26),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-3313.7	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Appendix C

VSP Reports of Calculated Minimum Sample Quantity
Report 21
Area of Concern – 3
Minimum Sample Quantity Calculation for Surface Water using Ecological Benchmarks and Delta Method 1

Random sampling locations for comparing a mean with a fixed threshold (parametric)

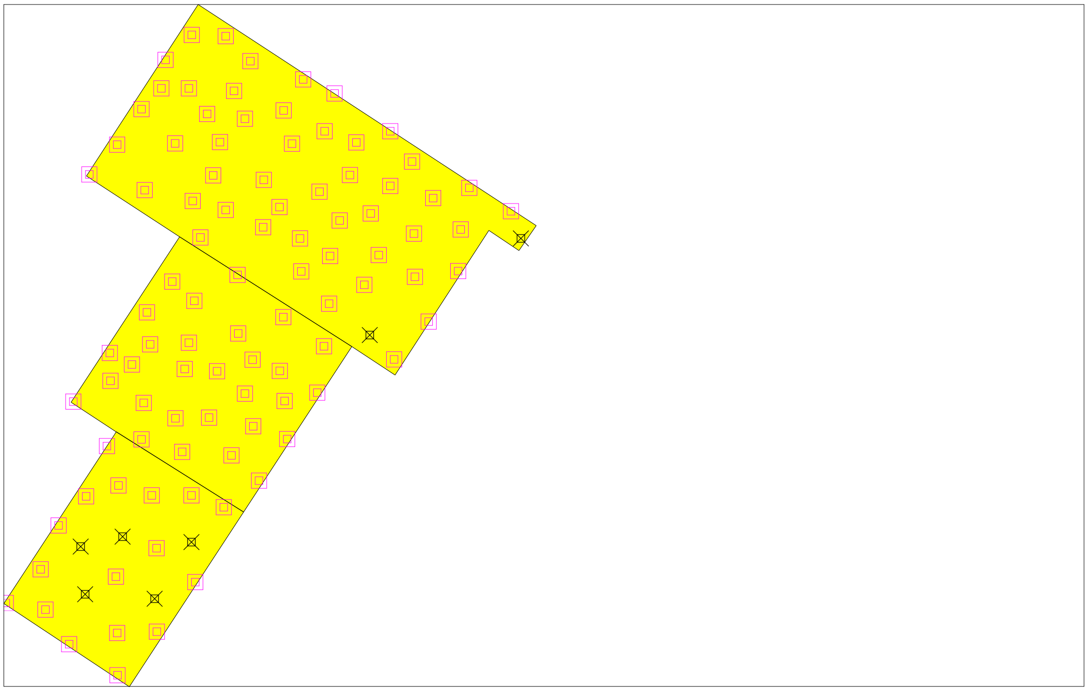
Summary

This report summarizes the sampling design, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design for Lead, the driving analyte (the analyte which required the largest number of samples). A figure that shows sampling locations in the field is also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean to a fixed threshold
Type of Sampling Design	Parametric
Sample Placement (Location) in the Field	Simple random sampling
Working (Null) Hypothesis	The mean value at the site exceeds the threshold
Formula for calculating number of sampling locations	Student's t-test
Calculated total number of samples	103
Number of samples on map [a]	103
Number of selected sample areas [b]	1
Specified sampling area [c]	606637.01 m^2
Total cost of sampling [d]	$52,500.00

[a] This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[d] Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.



Primary Sampling Objective
The primary purpose of sampling at this site is to compare a mean value of a site with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the mean value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the mean value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative hypothesis, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach
A parametric random sampling approach was used to determine the number of samples and to specify sampling locations. A parametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that parametric assumptions are reasonable. These assumptions will be examined in post-sampling data analysis.

Both parametric and non-parametric approaches rely on assumptions about the population. However, non-parametric approaches typically require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than the number of samples required by non-parametric approaches.

Locating the sample points randomly provides data that are separated by many distances, whereas systematic samples are all equidistant apart. Therefore, random sampling provides more information about the spatial structure of the potential contamination than systematic sampling does. As with systematic sampling, random sampling also provides information regarding the mean value, but there is the possibility that areas of the site will not be represented with the same frequency as if uniform grid sampling were performed.

Number of Total Samples: Calculation Equation and Inputs
The equation used to calculate the number of samples is based on a Student's t-test. For this site, the null hypothesis is rejected in favor of the alternative hypothesis if the sample mean is sufficiently smaller than the threshold. The number of samples to collect is calculated so that 1) there will be a high probability ($1-\beta$) of rejecting the null hypothesis if the alternative hypothesis is true and 2) a low probability (α) of rejecting the null hypothesis if the null hypothesis is true.

The formula used to calculate the number of samples is:

$$n = \frac{S^2}{\Delta^2}\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2 + 0.5Z_{1-\alpha}^2$$

where

n	is the number of samples,
S	is the estimated standard deviation of the measured values including analytical error,
Δ	is the width of the gray region,
α	is the acceptable probability of incorrectly concluding the site mean is less than the threshold,
β	is the acceptable probability of incorrectly concluding the site mean exceeds the threshold,
$Z_{1-\alpha}$	is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is $1-\alpha$,
$Z_{1-\beta}$	is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is $1-\beta$.

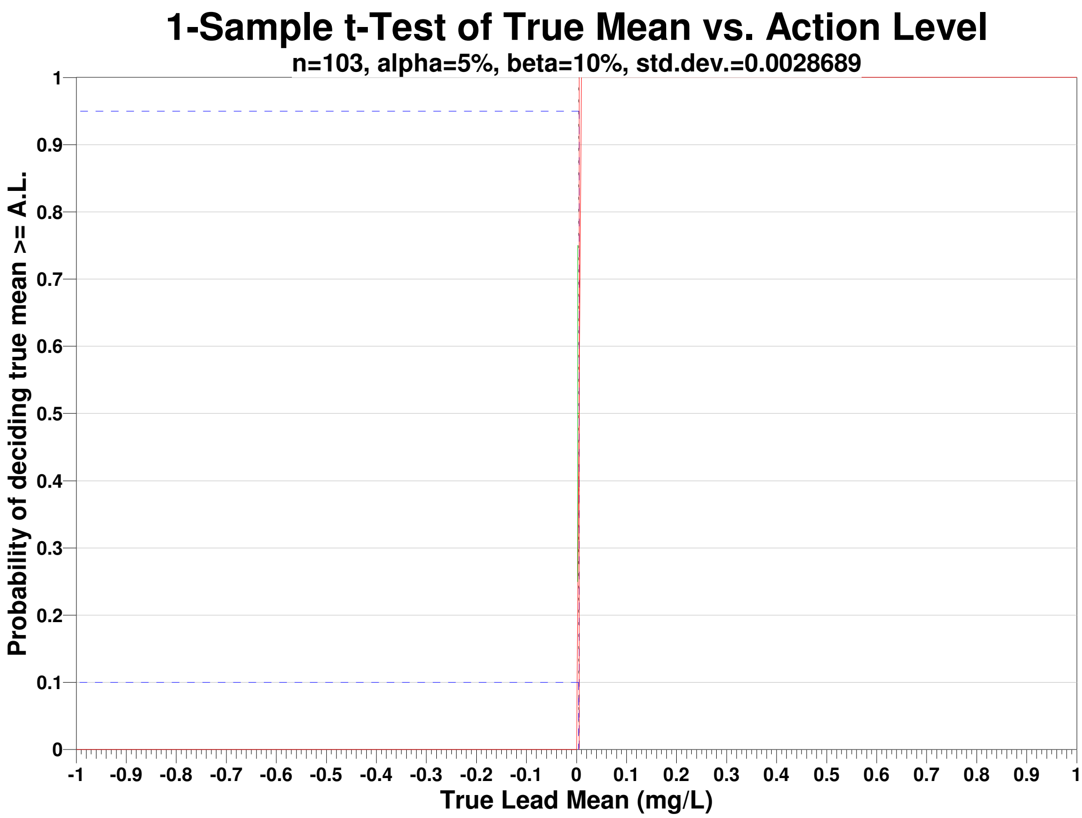
The values of these inputs that result in the calculated number of sampling locations are:

Analyte	**n**	**Parameter**					
		S	Δ	α	β	$Z_{1-\alpha}$ [a]	$Z_{1-\beta}$ [b]
00_Additional Samples	2	0.1 mg/L	10 mg/L	0.05	0.1	1.64485	1.28155
Barium	2	0.243435 mg/L	24.5228 mg/L	0.05	0.1	1.64485	1.28155
Chromium_ Hexavalent	2	0.00612178 mg/L	0.0427429 mg/L	0.05	0.1	1.64485	1.28155
Lead	103	0.0028689 mg/L	0.000835714 mg/L	0.05	0.1	1.64485	1.28155
Zinc	3	0.0207353 mg/L	0.0544286 mg/L	0.05	0.1	1.64485	1.28155

[a] This value is automatically calculated by VSP based upon the user defined value of α.
[b] This value is automatically calculated by VSP based upon the user defined value of β.

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000) for Lead, the driving analyte. It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true mean values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at $1-\alpha$ on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at $1-\alpha$. If any of the inputs change, the number of samples that result in the correct curve changes.



Statistical Assumptions

The assumptions associated with the formulas for computing the number of samples are:

1. the sample mean is normally distributed (this happens if the data are roughly symmetric or the sample size is more than 30; for extremely skewed data sets, additional samples may be required for the sample mean to be normally distributed),
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected randomly.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the sample locations were selected using a random process.

Sensitivity Analysis

The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that μ > action level and alpha (%), probability of mistakenly concluding that μ < action level. The following table shows the results of this analysis.

Number of Samples							
AL=25		α=5		α=10		α=15	
		s=0.48687	s=0.243435	s=0.48687	s=0.243435	s=0.48687	s=0.243435
LBGR=90	β=5	9132483	2283122	7226754	1806690	6066818	1516705
	β=10	7226755	1806690	5543787	1385948	4534147	1133538
	β=15	6066819	1516706	4534147	1133538	3625911	906479
LBGR=80	β=5	2283122	570782	1806690	451673	1516705	379177
	β=10	1806690	451674	1385948	346488	1133538	283385
	β=15	1516706	379178	1133538	283385	906479	226620
LBGR=70	β=5	1014722	253682	802974	200744	674092	168524

	β=10	802974	200745	615978	153995	503795	125950
	β=15	674093	168525	503795	125950	402880	100721

s = Standard Deviation
LBGR = Lower Bound of Gray Region (% of Action Level)
β = Beta (%), Probability of mistakenly concluding that μ > action level
α = Alpha (%), Probability of mistakenly concluding that μ < action level
AL = Action Level (Threshold)

Cost of Sampling
The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that are based on the number of samples collected and measured. Based on the numbers of samples determined above, the estimated total cost of sampling and analysis at this site is $52,500.00, which averages out to a per sample cost of $509.71. The following table summarizes the inputs and resulting cost estimates.

COST INFORMATION			
Cost Details	**Per Analysis**	**Per Sample**	**103 Samples**
Field collection costs		$100.00	$10,300.00
Analytical costs	$400.00	$400.00	$41,200.00
Sum of Field & Analytical costs		**$500.00**	**$51,500.00**
Fixed planning and validation costs			$1,000.00
Total cost			**$52,500.00**

Data Analysis for 00_Additional Samples
The following data points were entered by the user for analysis.

00_Additional Samples (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0	0
80	0	0	0	0	0	0	0	0	0	0
90	0	0	0	0	0	0				

SUMMARY STATISTICS for 00_Additional Samples	
n	96
Min	0
Max	0
Range	0
Mean	0

Median				0				
Variance				0				
StdDev				0				
Std Error				0				
Skewness				-1.#IND				
Interquartile Range				0				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0	0	0	0	0	0	0	0	0

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for 00_Additional Samples			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	-1.#IO	-1	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Lilliefors test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Lilliefors Test Statistic	0
Lilliefors 5% Critical Value	0.748

The calculated Lilliefors test statistic is less than the 5% Lilliefors critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

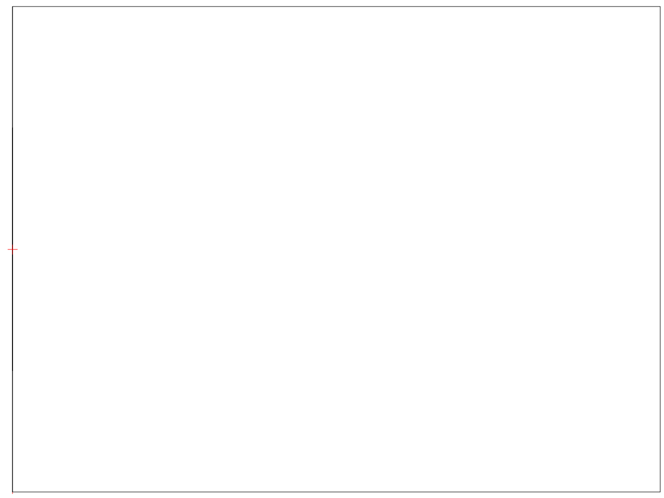
Data Plots for 00_Additional Samples
Graphical displays of the data are shown below.

The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

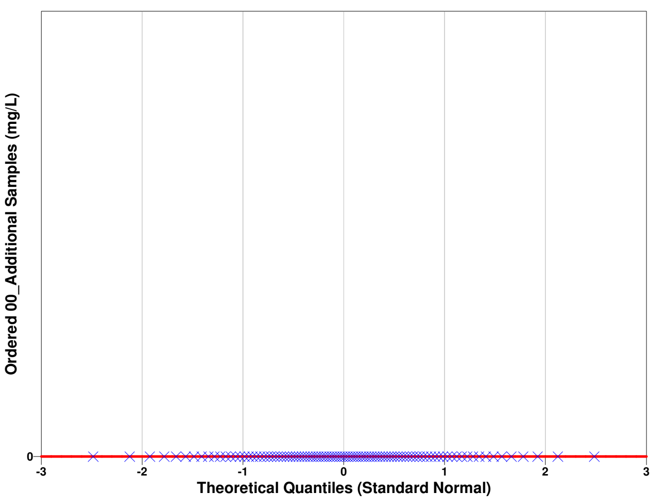
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box,

called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.



00_Additional Samples (mg/L)



For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for 00_Additional Samples

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Lilliefors test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST

Lilliefors Test Statistic	0
Lilliefors 5% Critical Value	0.09043

The calculated Lilliefors test statistic is less than the 5% Lilliefors critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0
95% Non-Parametric (Chebyshev) UCL	0

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=96 data,
AL is the action level or threshold (25),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=95 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.#IND	1.6611	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Data Analysis for Barium
The following data points were entered by the user for analysis.

Barium (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0491	0.3865	0.393	0.452	0.56	0.732	0.768			

SUMMARY STATISTICS for Barium	
n	7
Min	0.0491
Max	0.768

Range				0.7189				
Mean				0.47723				
Median				0.452				
Variance				0.059261				
StdDev				0.24344				
Std Error				0.09201				
Skewness				-0.61698				
Interquartile Range				0.3455				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0491	0.0491	0.0491	0.3865	0.452	0.732	0.768	0.768	0.768

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Barium	
Dixon Test Statistic	0.46933
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.0491 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.864
Shapiro-Wilk 5% Critical Value	0.788

The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.0491, do appear to follow a normal distribution at the 5% level of significance.

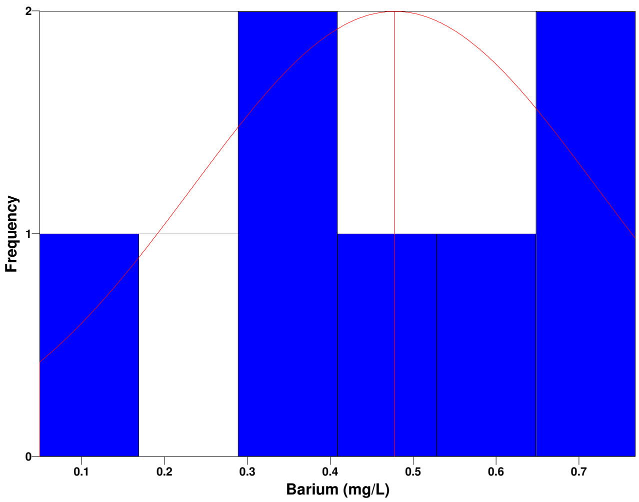
Data Plots for Barium
Graphical displays of the data are shown below.

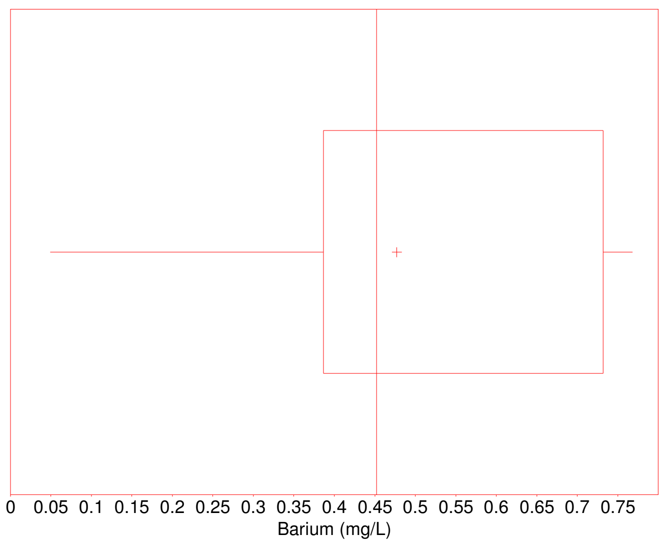
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

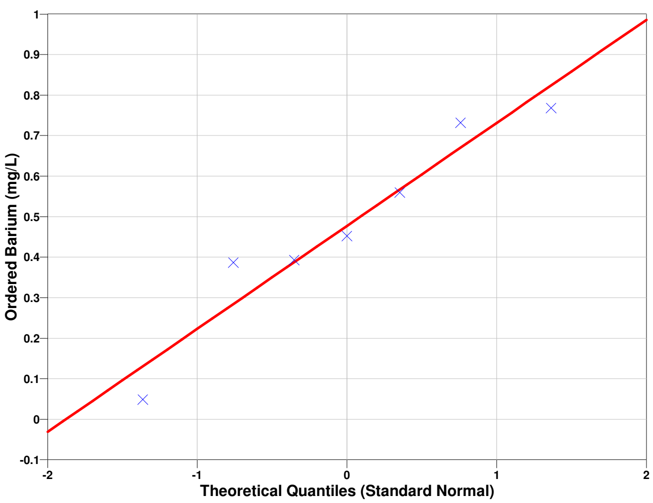
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends

to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Barium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9338
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.656
95% Non-Parametric (Chebyshev) UCL	0.8783

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0.656) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (25),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-266.52	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Chromium_ Hexavalent
The following data points were entered by the user for analysis.

Chromium_ Hexavalent (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.002	0.002	0.002	0.005	0.006	0.015	0.016			

SUMMARY STATISTICS for Chromium_ Hexavalent	
n	7
Min	0.002
Max	0.016
Range	0.014
Mean	0.0068571

Median	0.005
Variance	3.7476e-005
StdDev	0.0061218
Std Error	0.0023138
Skewness	0.96965
Interquartile Range	0.013

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.002	0.002	0.002	0.002	0.005	0.015	0.016	0.016	0.016

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Chromium_ Hexavalent	
Dixon Test Statistic	0
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.002 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8223
Shapiro-Wilk 5% Critical Value	0.788

The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.002, do appear to follow a normal distribution at the 5% level of significance.

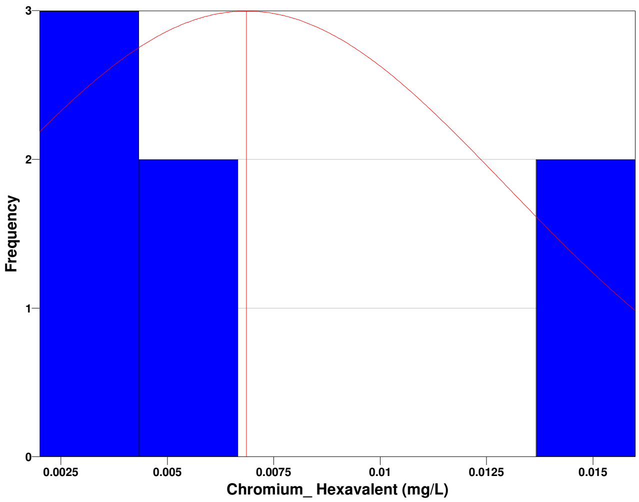
Data Plots for Chromium_ Hexavalent
Graphical displays of the data are shown below.

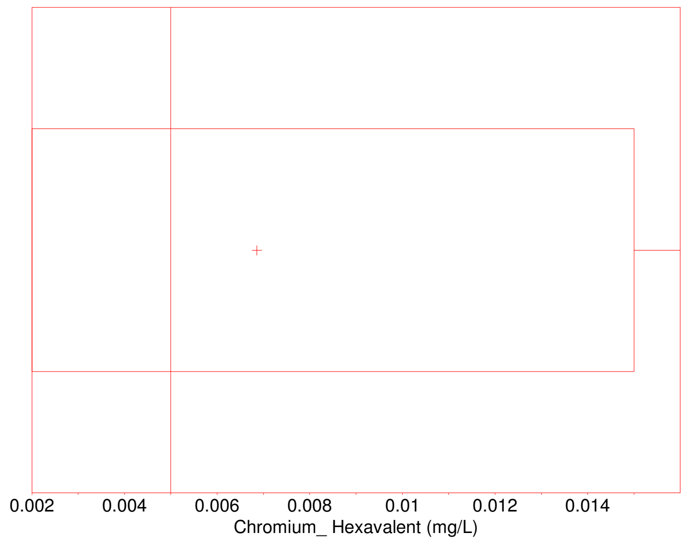
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

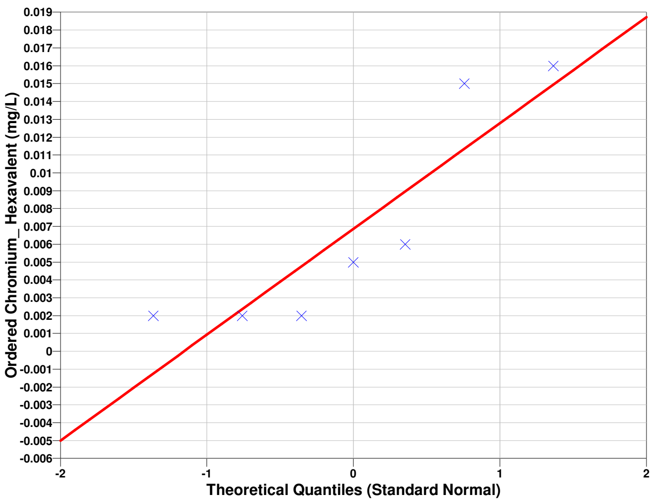
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted

individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Chromium_ Hexavalent

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7781
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance.

The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.01135
95% Non-Parametric (Chebyshev) UCL	0.01694

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.01694) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (25),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-18.473	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Data Analysis for Lead
The following data points were entered by the user for analysis.

Lead (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0014	0.00235	0.0032	0.004	0.0048	0.0053	0.0102			

SUMMARY STATISTICS for Lead	
n	7

Min				0.0014				
Max				0.0102				
Range				0.0088				
Mean				0.0044643				
Median				0.004				
Variance				8.2306e-006				
StdDev				0.0028689				
Std Error				0.0010843				
Skewness				1.4721				
Interquartile Range				0.00295				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0014	0.0014	0.0014	0.00235	0.004	0.0053	0.0102	0.0102	0.0102

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Lead	
Dixon Test Statistic	0.10795
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.0014 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8477
Shapiro-Wilk 5% Critical Value	0.788

The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.0014, do appear to follow a normal distribution at the 5% level of significance.

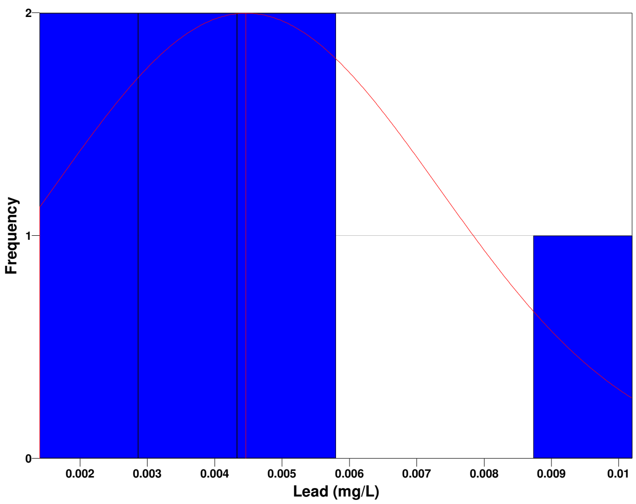
Data Plots for Lead
Graphical displays of the data are shown below.

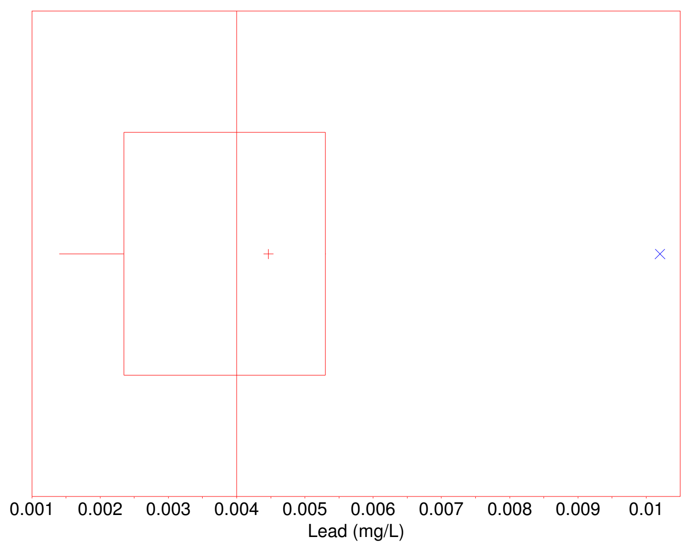
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

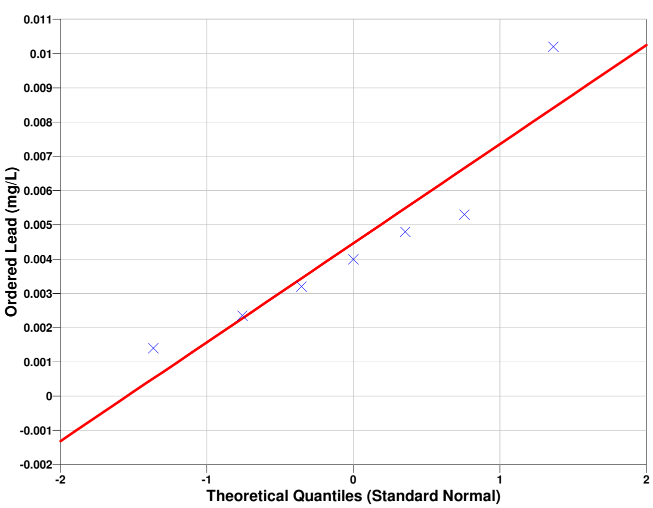
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box,

called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Lead

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST

Shapiro-Wilk Test Statistic	0.883
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.006571
95% Non-Parametric (Chebyshev) UCL	0.009191

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0.006571) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (25),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-0.77071	1.9432	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Data Analysis for Zinc
The following data points were entered by the user for analysis.

Zinc (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0184	0.0185	0.0203	0.0217	0.0228	0.0309	0.0758			

SUMMARY STATISTICS for Zinc	
n	7
Min	0.0184
Max	0.0758

Range				0.0574				
Mean				0.029771				
Median				0.0217				
Variance				0.00042995				
StdDev				0.020735				
Std Error				0.0078372				
Skewness				2.4315				
Interquartile Range				0.0124				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0184	0.0184	0.0184	0.0185	0.0217	0.0309	0.0758	0.0758	0.0758

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Zinc	
Dixon Test Statistic	0.0017422
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.0184 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6561
Shapiro-Wilk 5% Critical Value	0.788

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.0184, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

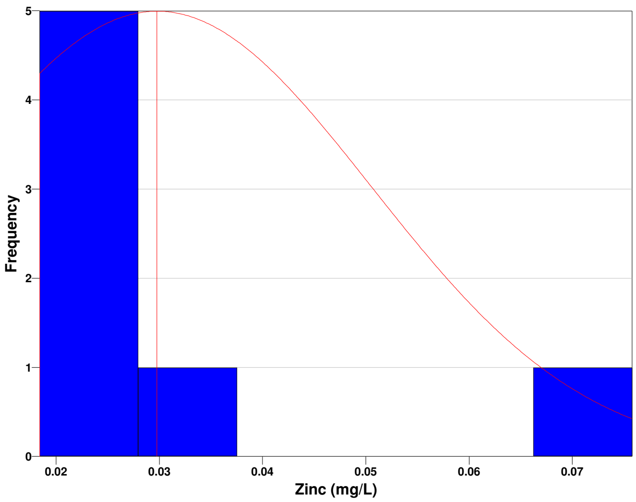
Data Plots for Zinc
Graphical displays of the data are shown below.

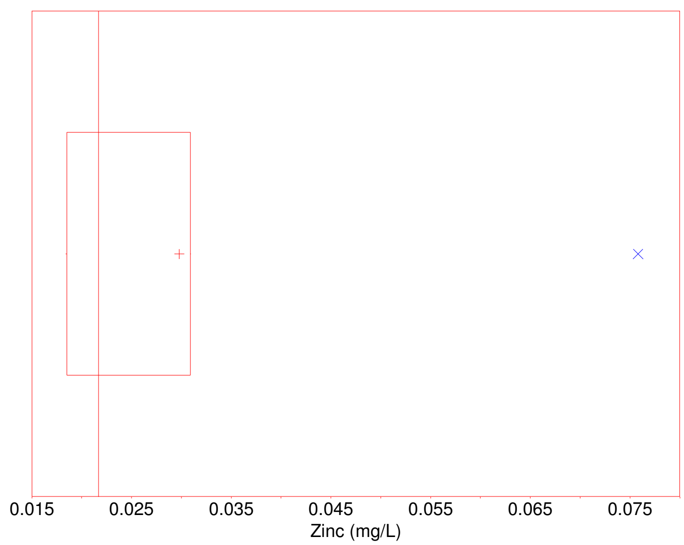
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

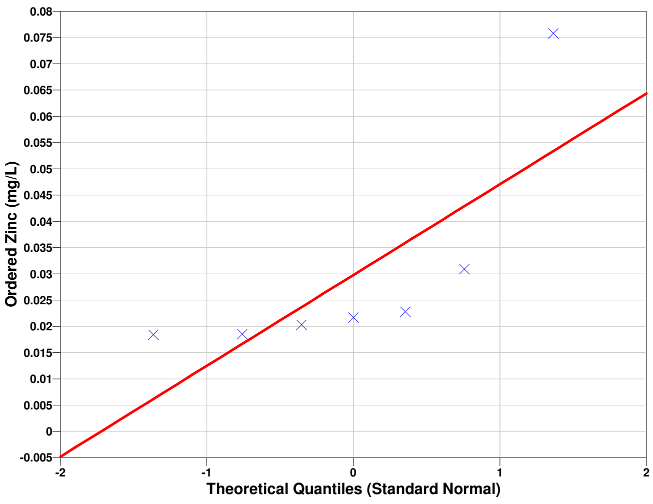
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box,

called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Zinc

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST

Shapiro-Wilk Test Statistic	0.6167
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.045
95% Non-Parametric (Chebyshev) UCL	0.06393

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.06393) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (25),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-6.9449	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

This report was automatically produced* by Visual Sample Plan (VSP) software version 5.3.1.
Software and documentation available at http://dqo.pnl.gov/vsp

* - The report contents may have been modified or reformatted by end-user of software.

Appendix C

VSP Reports of Calculated Minimum Sample Quantity
Report 22
Area of Concern – 3
Minimum Sample Quantity Calculation for Surface Water using Ecological Benchmarks and Delta Method 2

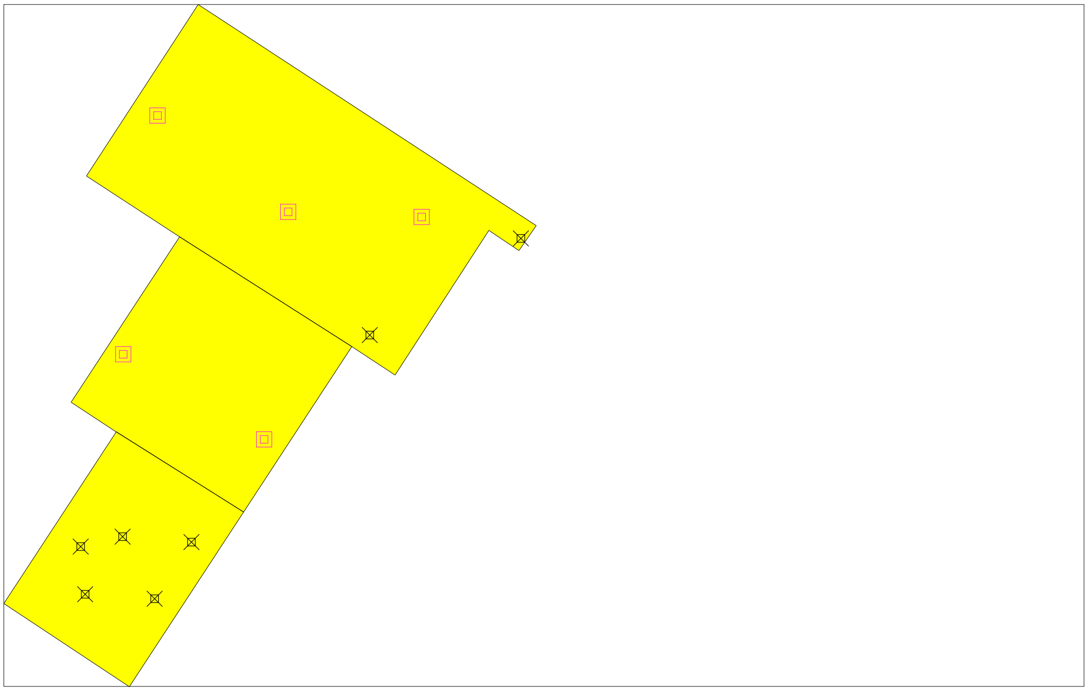
Random sampling locations for comparing a mean with a fixed threshold (parametric)

Summary
This report summarizes the sampling design, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design for Lead, the driving analyte (the analyte which required the largest number of samples). A figure that shows sampling locations in the field and a table that lists sampling location coordinates are also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean to a fixed threshold
Type of Sampling Design	Parametric
Sample Placement (Location) in the Field	Simple random sampling
Working (Null) Hypothesis	The mean value at the site exceeds the threshold
Formula for calculating number of sampling locations	Student's t-test
Calculated total number of samples	12
Number of samples on map [a]	12
Number of selected sample areas [b]	1
Specified sampling area [c]	606637.01 m^2
Total cost of sampling [d]	$7,000.00

[a] This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[d] Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.



Area: Area 1					
X Coord	**Y Coord**	**Label**	**Value**	**Type**	**Historical**
680108.0130	3083101.3520	J-57SD		Manual	T
680413.8310	3083297.0130	J-58SD		Manual	T
679530.9430	3082575.4480	G-36SD		Manual	T
679606.6840	3082692.3830	G-37SD		Manual	T
679671.3170	3082565.9250	G-46SD		Manual	T
679745.9820	3082681.3860	G-47SD		Manual	T
679521.7790	3082672.0220	J-54SD		Manual	T
679677.4812	3083546.0405		0	Adaptive-Fill	
679608.0161	3083061.8866		0	Adaptive-Fill	
679942.0091	3083350.6112		0	Adaptive-Fill	
679893.5513	3082889.3600		0	Adaptive-Fill	
680212.9052	3083340.4252		0	Adaptive-Fill	

Primary Sampling Objective
The primary purpose of sampling at this site is to compare a mean value of a site with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the mean value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the mean value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative hypothesis, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach
A parametric random sampling approach was used to determine the number of samples and to specify sampling locations. A parametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that parametric assumptions are reasonable. These assumptions will be examined in post-sampling data analysis.

Both parametric and non-parametric approaches rely on assumptions about the population. However, non-parametric

approaches typically require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than the number of samples required by non-parametric approaches.

Locating the sample points randomly provides data that are separated by many distances, whereas systematic samples are all equidistant apart. Therefore, random sampling provides more information about the spatial structure of the potential contamination than systematic sampling does. As with systematic sampling, random sampling also provides information regarding the mean value, but there is the possibility that areas of the site will not be represented with the same frequency as if uniform grid sampling were performed.

Number of Total Samples: Calculation Equation and Inputs
The equation used to calculate the number of samples is based on a Student's t-test. For this site, the null hypothesis is rejected in favor of the alternative hypothesis if the sample mean is sufficiently smaller than the threshold. The number of samples to collect is calculated so that 1) there will be a high probability ($1-\beta$) of rejecting the null hypothesis if the alternative hypothesis is true and 2) a low probability (α) of rejecting the null hypothesis if the null hypothesis is true.

The formula used to calculate the number of samples is:

$$n = \frac{S^2}{\Delta^2}\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2 + 0.5Z_{1-\alpha}^2$$

where
n is the number of samples,
S is the estimated standard deviation of the measured values including analytical error,
Δ is the width of the gray region,
α is the acceptable probability of incorrectly concluding the site mean is less than the threshold,
β is the acceptable probability of incorrectly concluding the site mean exceeds the threshold,
$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is $1-\alpha$,
$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is $1-\beta$.

The values of these inputs that result in the calculated number of sampling locations are:

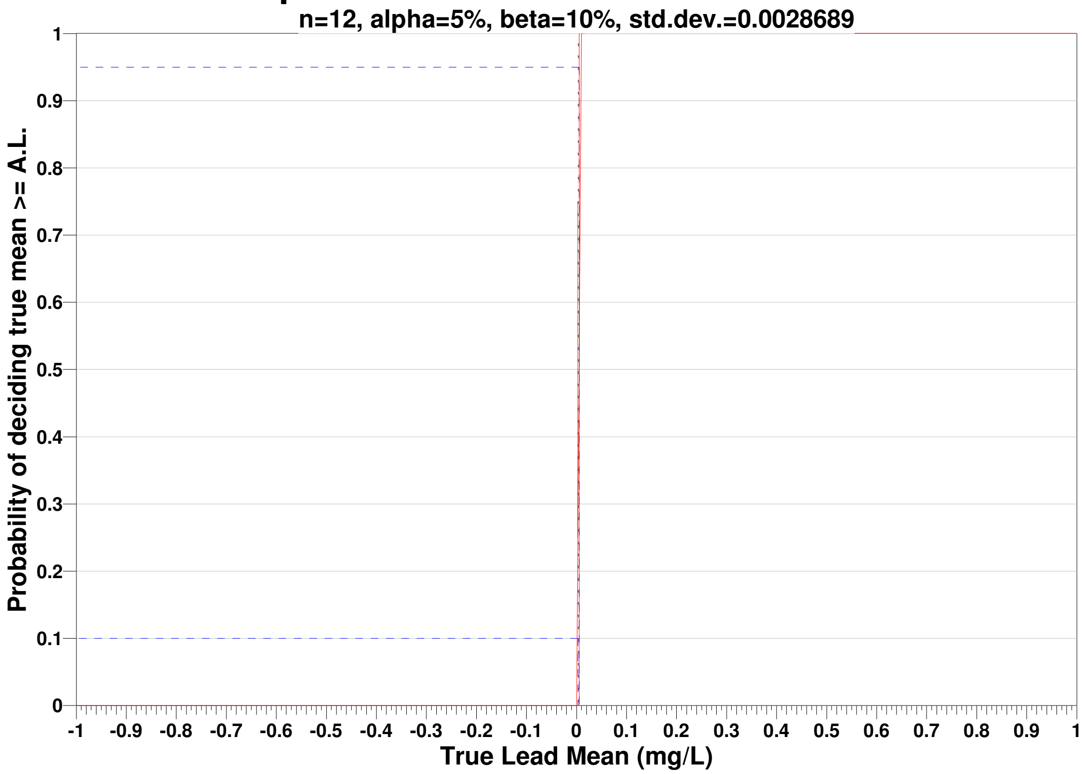
Analyte	n	Parameter					
		S	**Δ**	**α**	**β**	**$Z_{1-\alpha}$** [a]	**$Z_{1-\beta}$** [b]
00_Additional Samples	2	0.1 mg/L	10 mg/L	0.05	0.1	1.64485	1.28155
Barium	2	0.243435 mg/L	12.5 mg/L	0.05	0.1	1.64485	1.28155
Chromium_ Hexavalent	2	0.00612178 mg/L	0.0248 mg/L	0.05	0.1	1.64485	1.28155
Lead	12	0.0028689 mg/L	0.00265 mg/L	0.05	0.1	1.64485	1.28155
Zinc	4	0.0207353 mg/L	0.0421 mg/L	0.05	0.1	1.64485	1.28155

[a] This value is automatically calculated by VSP based upon the user defined value of α.
[b] This value is automatically calculated by VSP based upon the user defined value of β.

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000) for Lead, the driving analyte. It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true mean values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at $1-\alpha$ on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at $1-\alpha$. If any of the inputs change, the number of samples that result in the correct curve changes.

1-Sample t-Test of True Mean vs. Action Level



Statistical Assumptions
The assumptions associated with the formulas for computing the number of samples are:

1. the sample mean is normally distributed (this happens if the data are roughly symmetric or the sample size is more than 30; for extremely skewed data sets, additional samples may be required for the sample mean to be normally distributed),
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected randomly.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the sample locations were selected using a random process.

Sensitivity Analysis
The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that μ > action level and alpha (%), probability of mistakenly concluding that μ < action level. The following table shows the results of this analysis.

Number of Samples							
AL=0.0842		α=5		α=10		α=15	
		s=0.0414706	s=0.0207353	s=0.0414706	s=0.0207353	s=0.0414706	s=0.0207353
LBGR=90	β=5	66261	16567	52433	13109	44018	11005
	β=10	52434	13110	40223	10057	32898	8225
	β=15	44018	11006	32898	8225	26308	6578
LBGR=80	β=5	16567	4143	13109	3278	11005	2752
	β=10	13110	3279	10057	2515	8225	2057
	β=15	11006	2753	8225	2057	6578	1645
LBGR=70	β=5	7364	1842	5827	1458	4892	1224

	β=10	5828	1458	4470	1119	3656	915
	β=15	4893	1225	3656	915	2924	732

s = Standard Deviation
LBGR = Lower Bound of Gray Region (% of Action Level)
β = Beta (%), Probability of mistakenly concluding that μ > action level
α = Alpha (%), Probability of mistakenly concluding that μ < action level
AL = Action Level (Threshold)

Cost of Sampling
The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that are based on the number of samples collected and measured. Based on the numbers of samples determined above, the estimated total cost of sampling and analysis at this site is $7,000.00, which averages out to a per sample cost of $583.33. The following table summarizes the inputs and resulting cost estimates.

COST INFORMATION			
Cost Details	**Per Analysis**	**Per Sample**	**12 Samples**
Field collection costs		$100.00	$1,200.00
Analytical costs	$400.00	$400.00	$4,800.00
Sum of Field & Analytical costs		**$500.00**	**$6,000.00**
Fixed planning and validation costs			$1,000.00
Total cost			**$7,000.00**

Data Analysis for 00_Additional Samples
The following data points were entered by the user for analysis.

00_Additional Samples (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0	0	0	0	0					

SUMMARY STATISTICS for 00_Additional Samples								
n	5							
Min	0							
Max	0							
Range	0							
Mean	0							
Median	0							
Variance	0							
StdDev	0							
Std Error	0							
Skewness	-1.#IND							
Interquartile Range	0							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0	0	0	0	0	0	0	0	0

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for 00_Additional Samples	
Dixon Test Statistic	0
Dixon 5% Critical Value	0

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	1.061e+292
Shapiro-Wilk 5% Critical Value	1.376e-313

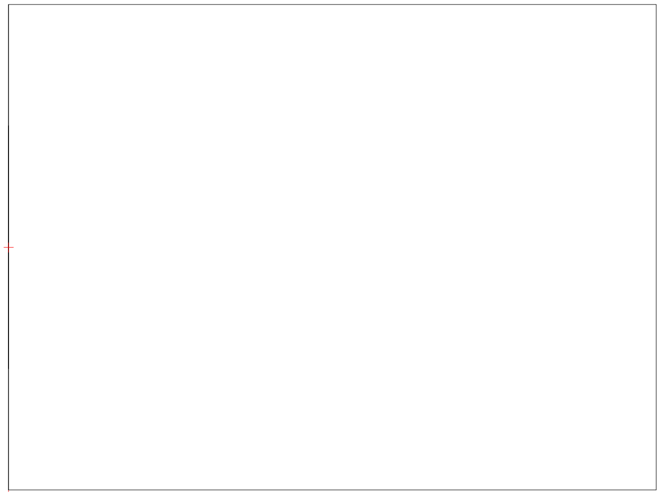
The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

Data Plots for 00_Additional Samples
Graphical displays of the data are shown below.

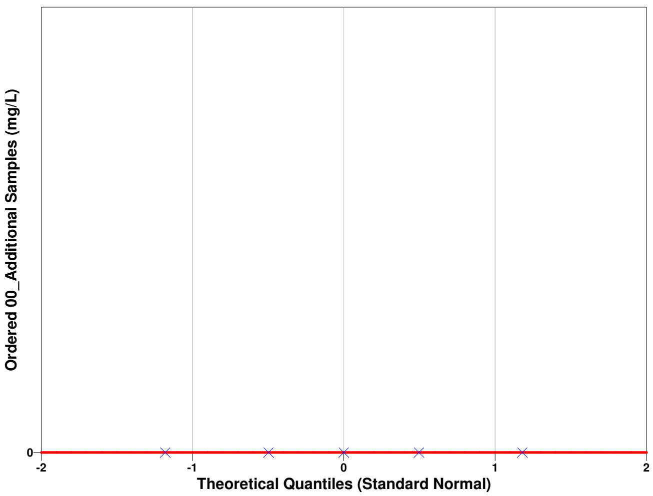
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.



00_Additional Samples (mg/L)



For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for 00_Additional Samples
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0
Shapiro-Wilk 5% Critical Value	0.762

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0

95% Non-Parametric (Chebyshev) UCL	0

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=5 data,
AL is the action level or threshold (0.0842),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=4 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.#IND	2.1318	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
-1	-1	Reject

Data Analysis for Barium
The following data points were entered by the user for analysis.

Barium (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0491	0.3865	0.393	0.452	0.56	0.732	0.768			

SUMMARY STATISTICS for Barium	
n	7
Min	0.0491
Max	0.768
Range	0.7189
Mean	0.47723
Median	0.452
Variance	0.059261

StdDev				0.24344				
Std Error				0.09201				
Skewness				-0.61698				
Interquartile Range				0.3455				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0491	0.0491	0.0491	0.3865	0.452	0.732	0.768	0.768	0.768

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Barium	
Dixon Test Statistic	0.46933
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.0491 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.864
Shapiro-Wilk 5% Critical Value	0.788

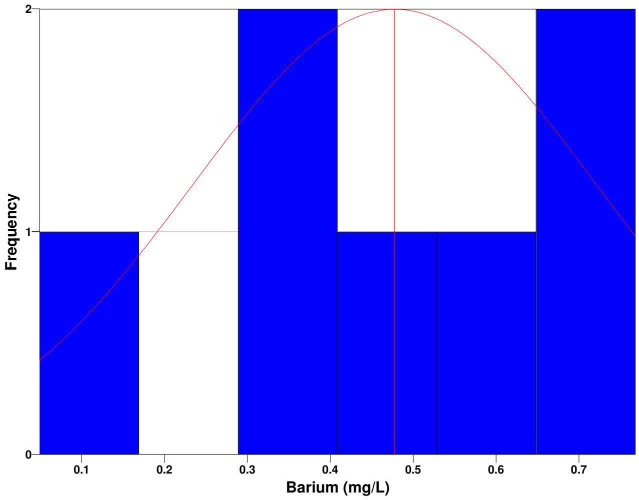
The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.0491, do appear to follow a normal distribution at the 5% level of significance.

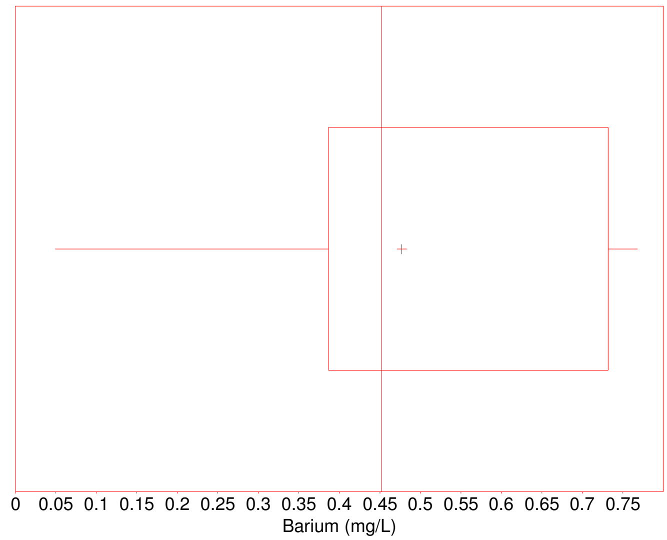
Data Plots for Barium
Graphical displays of the data are shown below.

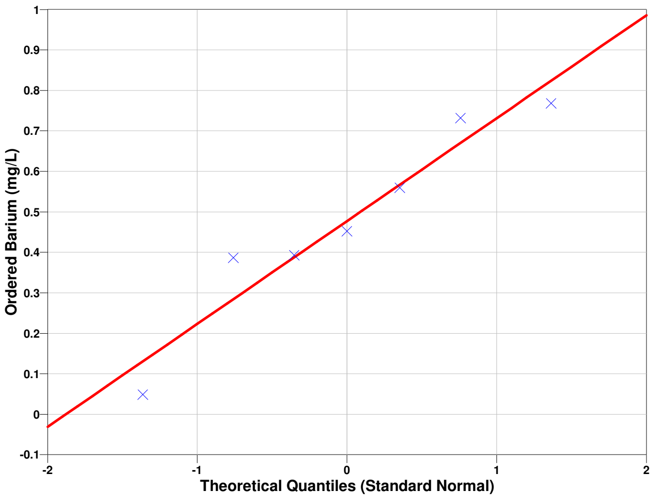
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Barium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.9338
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that

assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.656
95% Non-Parametric (Chebyshev) UCL	0.8783

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0.656) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (0.0842),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-266.52	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Data Analysis for Chromium_ Hexavalent
The following data points were entered by the user for analysis.

Chromium_ Hexavalent (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.002	0.002	0.002	0.005	0.006	0.015	0.016			

SUMMARY STATISTICS for Chromium_ Hexavalent	
n	7
Min	0.002
Max	0.016
Range	0.014
Mean	0.0068571
Median	0.005
Variance	3.7476e-005
StdDev	0.0061218
Std Error	0.0023138
Skewness	0.96965

Interquartile Range				0.013				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.002	0.002	0.002	0.002	0.005	0.015	0.016	0.016	0.016

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Chromium_ Hexavalent	
Dixon Test Statistic	0
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.002 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8223
Shapiro-Wilk 5% Critical Value	0.788

The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.002, do appear to follow a normal distribution at the 5% level of significance.

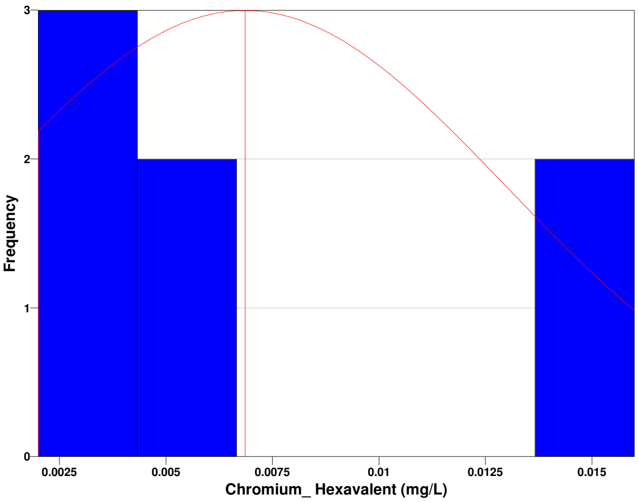
Data Plots for Chromium_ Hexavalent
Graphical displays of the data are shown below.

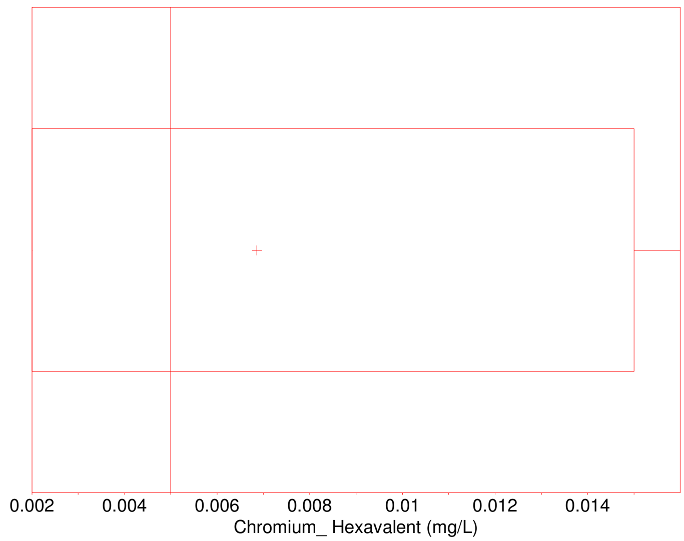
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

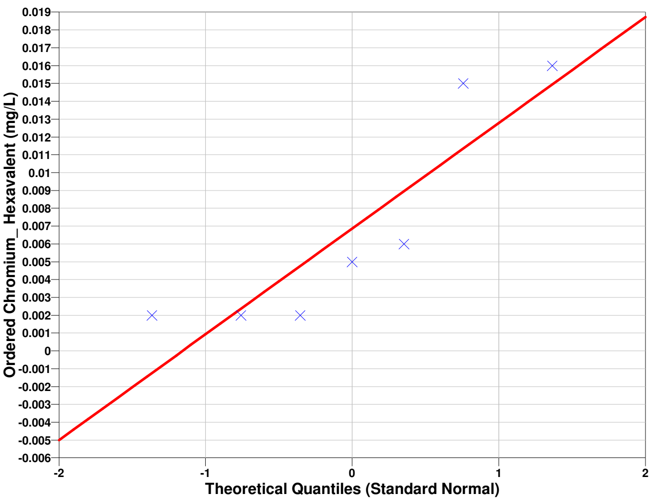
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight

line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Chromium_ Hexavalent
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7781
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN

95% Parametric UCL	0.01135
95% Non-Parametric (Chebyshev) UCL	0.01694

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.01694) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (0.0842),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-18.473	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

Data Analysis for Lead
The following data points were entered by the user for analysis.

Lead (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0014	0.00235	0.0032	0.004	0.0048	0.0053	0.0102			

SUMMARY STATISTICS for Lead	
n	7
Min	0.0014
Max	0.0102
Range	0.0088
Mean	0.0044643
Median	0.004

Variance				8.2306e-006				
StdDev				0.0028689				
Std Error				0.0010843				
Skewness				1.4721				
Interquartile Range				0.00295				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0014	0.0014	0.0014	0.00235	0.004	0.0053	0.0102	0.0102	0.0102

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Lead	
Dixon Test Statistic	0.10795
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.0014 is not an outlier at the 5% significance level.

Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8477
Shapiro-Wilk 5% Critical Value	0.788

The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.0014, do appear to follow a normal distribution at the 5% level of significance.

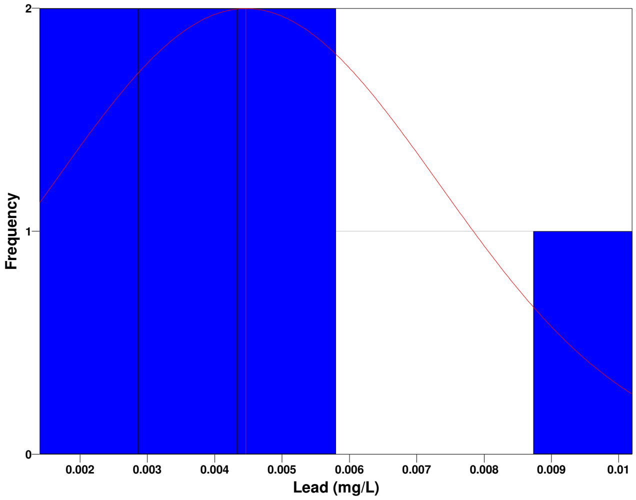
Data Plots for Lead
Graphical displays of the data are shown below.

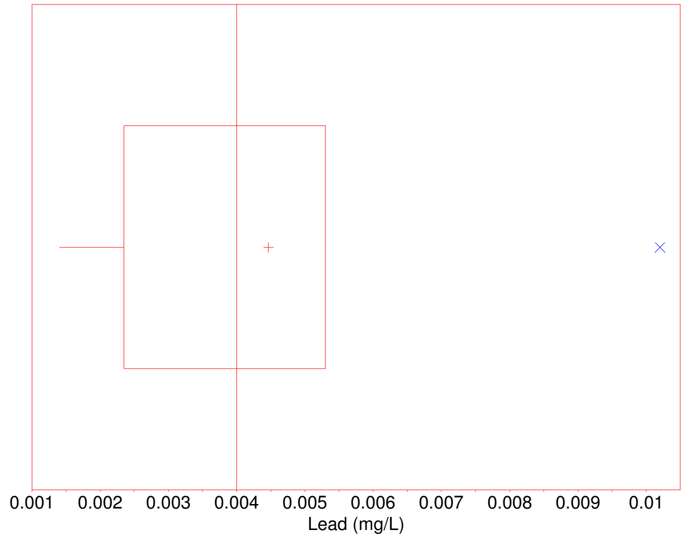
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

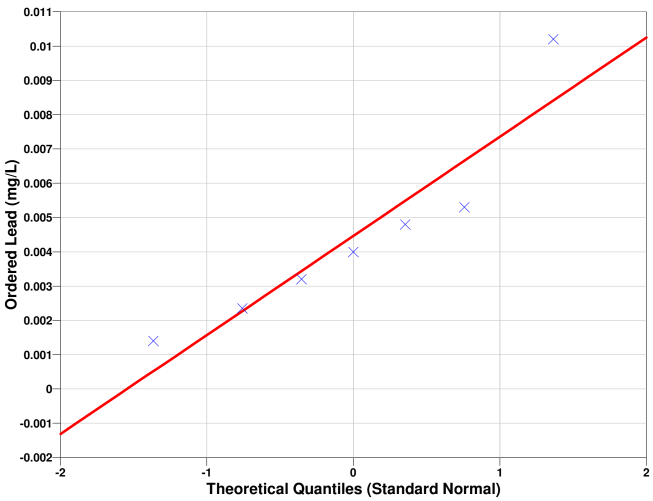
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the

distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Lead

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.883
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic exceeds the 5% Shapiro-Wilk critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.006571
95% Non-Parametric (Chebyshev) UCL	0.009191

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0.006571) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (0.0842),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-0.77071	1.9432	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Data Analysis for Zinc
The following data points were entered by the user for analysis.

Zinc (mg/L)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0184	0.0185	0.0203	0.0217	0.0228	0.0309	0.0758			

SUMMARY STATISTICS for Zinc	
n	7
Min	0.0184
Max	0.0758
Range	0.0574
Mean	0.029771
Median	0.0217
Variance	0.00042995
StdDev	0.020735

Std Error				0.0078372				
Skewness				2.4315				
Interquartile Range				0.0124				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0184	0.0184	0.0184	0.0185	0.0217	0.0309	0.0758	0.0758	0.0758

Outlier Test
Dixon's extreme value test was performed to test whether the lowest value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

DIXON'S OUTLIER TEST for Zinc	
Dixon Test Statistic	0.0017422
Dixon 5% Critical Value	0.507

The calculated test statistic does not exceed the critical value, so the test cannot reject the null hypothesis that there are no outliers in the data, and concludes that the minimum value 0.0184 is not an outlier at the 5% significance level.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Dixon's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6561
Shapiro-Wilk 5% Critical Value	0.788

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the minimum value 0.0184, do not appear to follow a normal distribution at the 5% level of significance. Dixon's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

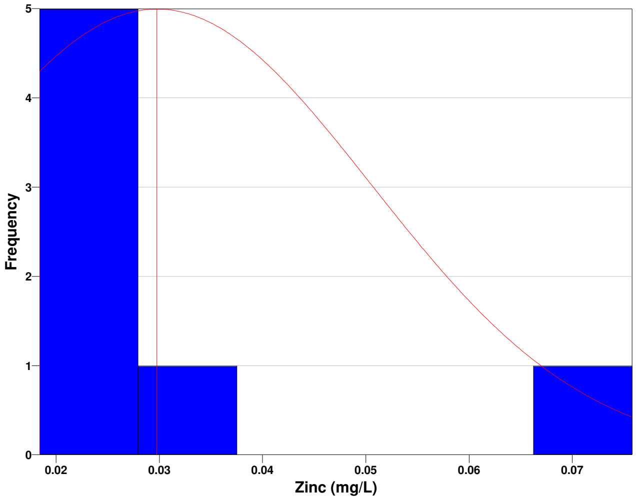
Data Plots for Zinc
Graphical displays of the data are shown below.

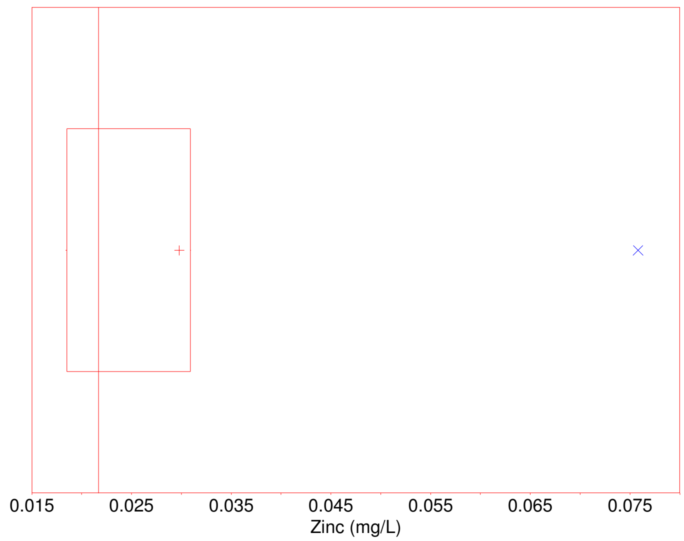
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

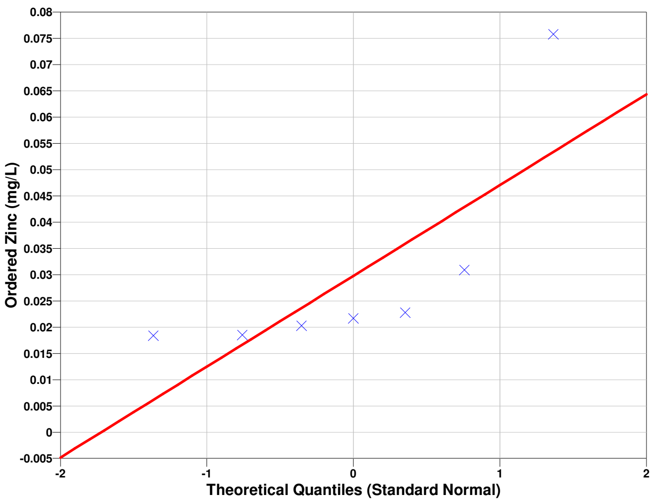
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted

individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Zinc
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6167
Shapiro-Wilk 5% Critical Value	0.803

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance.

The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.045
95% Non-Parametric (Chebyshev) UCL	0.06393

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.06393) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=7 data,
AL is the action level or threshold (0.0842),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=6 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-6.9449	1.9432	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
7	6	Reject

This report was automatically produced* by Visual Sample Plan (VSP) software version 5.3.1.
Software and documentation available at http://dqo.pnl.gov/vsp

* - The report contents may have been modified or reformatted by end-user of software.

Appendix C

VSP Reports of Calculated Minimum Sample Quantity
Report 23
Area of Concern – 3
Minimum Sample Quantity Calculation for Sediment using Human Health Benchmarks and Delta Method 1

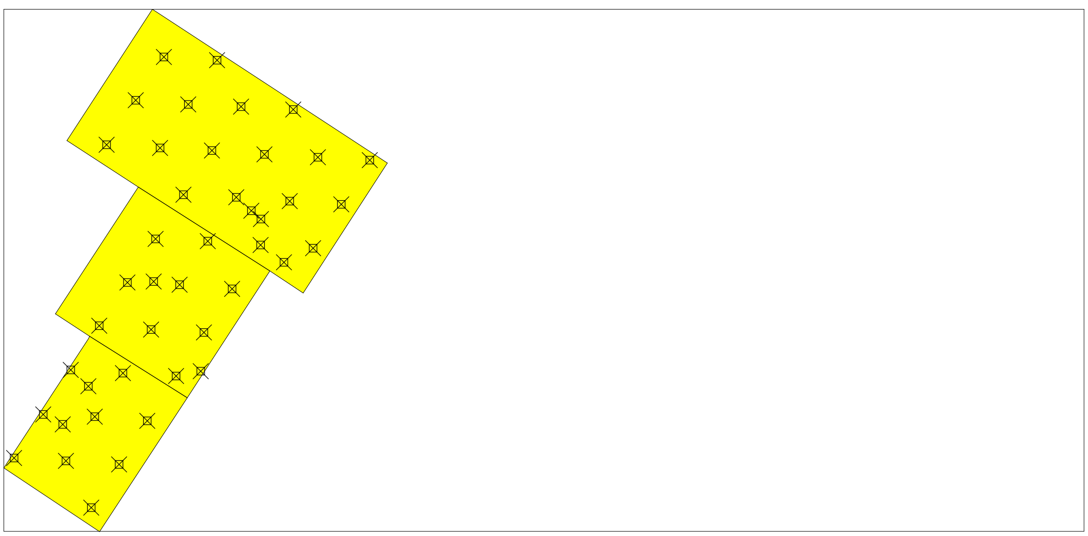
Random sampling locations for comparing a mean with a fixed threshold (parametric)

Summary
This report summarizes the sampling design, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design for Aluminum, the driving analyte (the analyte which required the largest number of samples). A figure that shows sampling locations in the field and a table that lists sampling location coordinates are also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean to a fixed threshold
Type of Sampling Design	Parametric
Sample Placement (Location) in the Field	Simple random sampling
Working (Null) Hypothesis	The mean value at the site exceeds the threshold
Formula for calculating number of sampling locations	Student's t-test
Calculated total number of samples	2
Number of samples on map [a]	43
Number of selected sample areas [b]	1
Specified sampling area [c]	602117.04 m^2
Total cost of sampling [d]	$2,000.00

[a] This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[d] Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.



Area: Area 1

X Coord	Y Coord	Label	Value	Type	Historical
679638.4660	3083412.5610	G-21SD		Manual	T
679715.3150	3083530.0190	G-22SD		Manual	T
679789.8310	3083644.9360	G-23SD		Manual	T
679780.1110	3083404.0250	G-24SD		Manual	T
679854.2250	3083519.8220	G-25SD		Manual	T
679931.3970	3083636.4060	G-26SD		Manual	T
679841.7740	3083280.2350	G-33SD		Manual	T
679917.7660	3083397.4160	G-34SD		Manual	T
679994.2070	3083513.4470	G-35SD		Manual	T
679982.2770	3083273.0650	G-42SD		Manual	T
680056.9810	3083387.3300	G-43SD		Manual	T
680132.6500	3083505.4560	G-44SD		Manual	T
680046.7830	3083146.9990	G-51SD		Manual	T
680123.4320	3083263.0010	G-52SD		Manual	T
680198.0580	3083379.8150	G-53SD		Manual	T
680185.4120	3083138.8470	G-54SD		Manual	T
680260.4210	3083254.8070	G-55SD		Manual	T
680335.9700	3083372.0200	G-56SD		Manual	T
680022.0080	3083237.4720	J-44SD		Manual	T
680047.0950	3083215.9420	J-45SD		Manual	T
680108.0130	3083101.3520	J-57SD		Manual	T
679619.1240	3082932.8980	G-30SD		Manual	T
679693.4050	3083047.5490	G-31SD		Manual	T
679768.2260	3083162.7270	G-32SD		Manual	T
679756.1090	3082922.9390	G-39SD		Manual	T
679832.1580	3083041.8710	G-40SD		Manual	T
679906.4210	3083156.7540	G-41SD		Manual	T
679822.0740	3082799.5750	G-48SD		Manual	T
679896.6120	3082915.6660	G-49SD		Manual	T
679971.2150	3083030.7920	G-50SD		Manual	T
679887.4330	3082812.9360	J-46SD		Manual	T
679763.3990	3083050.0550	J-56SD		Manual	T
679393.4380	3082582.9470	G-27SD		Manual	T
679470.2860	3082698.0210	G-28SD		Manual	T
679543.3140	3082816.1060	G-29SD		Manual	T
679530.9430	3082575.4480	G-36SD		Manual	T
679606.6840	3082692.3830	G-37SD		Manual	T
679681.4650	3082807.7990	G-38SD		Manual	T
679597.1880	3082450.9230	G-45SD		Manual	T
679671.3170	3082565.9250	G-46SD		Manual	T

679745.9820	3082681.3860	G-47SD		Manual	T
679521.7790	3082672.0220	J-54SD		Manual	T
679590.0920	3082773.1840	J-55SD		Manual	T

Primary Sampling Objective
The primary purpose of sampling at this site is to compare a mean value of a site with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the mean value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the mean value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative hypothesis, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach
A parametric random sampling approach was used to determine the number of samples and to specify sampling locations. A parametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that parametric assumptions are reasonable. These assumptions will be examined in post-sampling data analysis.

Both parametric and non-parametric approaches rely on assumptions about the population. However, non-parametric approaches typically require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than the number of samples required by non-parametric approaches.

Locating the sample points randomly provides data that are separated by many distances, whereas systematic samples are all equidistant apart. Therefore, random sampling provides more information about the spatial structure of the potential contamination than systematic sampling does. As with systematic sampling, random sampling also provides information regarding the mean value, but there is the possibility that areas of the site will not be represented with the same frequency as if uniform grid sampling were performed.

Number of Total Samples: Calculation Equation and Inputs
The equation used to calculate the number of samples is based on a Student's t-test. For this site, the null hypothesis is rejected in favor of the alternative hypothesis if the sample mean is sufficiently smaller than the threshold. The number of samples to collect is calculated so that 1) there will be a high probability ($1-\beta$) of rejecting the null hypothesis if the alternative hypothesis is true and 2) a low probability (α) of rejecting the null hypothesis if the null hypothesis is true.

The formula used to calculate the number of samples is:

$$n = \frac{S^2}{\Delta^2}\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2 + 0.5Z_{1-\alpha}^2$$

where
n is the number of samples,
S is the estimated standard deviation of the measured values including analytical error,
Δ is the width of the gray region,
α is the acceptable probability of incorrectly concluding the site mean is less than the threshold,
β is the acceptable probability of incorrectly concluding the site mean exceeds the threshold,
$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is $1-\alpha$,
$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is $1-\beta$.

The values of these inputs that result in the calculated number of sampling locations are:

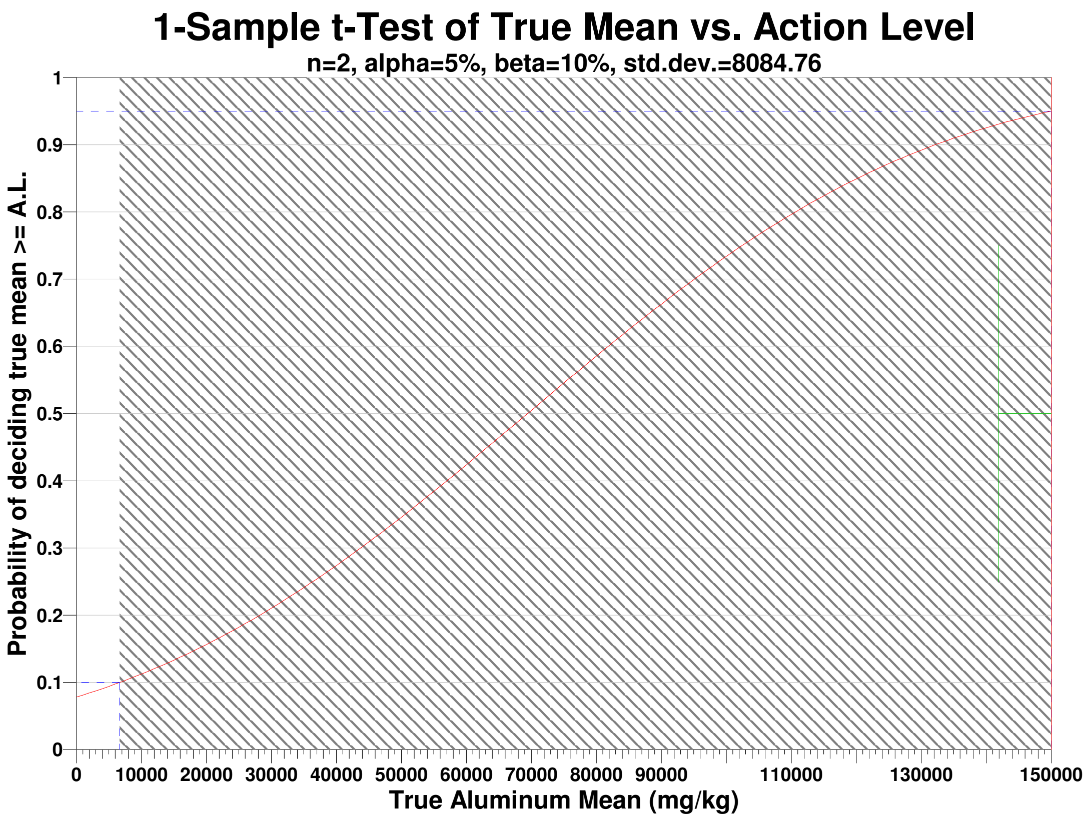
Analyte	n	Parameter					
		S	Δ	α	β	$Z_{1-\alpha}$ [a]	$Z_{1-\beta}$ [b]
New Location	2	0.1 mg/kg	10 mg/kg	0.05	0.1	1.64485	1.28155
1_2_4-Trimethylbenzene	2	0.000903411 mg/kg	37000 mg/kg	0.05	0.1	1.64485	1.28155
Acetone	2	0.107526 mg/kg	660000 mg/kg	0.05	0.1	1.64485	1.28155
Aluminum	2	8084.76 mg/kg	143331 mg/kg	0.05	0.1	1.64485	1.28155

Arsenic	2	2.98866 mg/kg	107.469 mg/kg	0.05	0.1	1.64485	1.28155
Barium	2	302.768 mg/kg	22810.6 mg/kg	0.05	0.1	1.64485	1.28155
bis(2-Ethylhexyl)phthalate	2	0.132826 mg/kg	239.897 mg/kg	0.05	0.1	1.64485	1.28155
Cadmium	2	0.133983 mg/kg	1099.88 mg/kg	0.05	0.1	1.64485	1.28155
Carbon disulfide	2	0.00443094 mg/kg	73000 mg/kg	0.05	0.1	1.64485	1.28155
Chromium	2	7.12413 mg/kg	35993.7 mg/kg	0.05	0.1	1.64485	1.28155
Cobalt	2	2.15433 mg/kg	31998.2 mg/kg	0.05	0.1	1.64485	1.28155
Copper	2	10.8021 mg/kg	20992.5 mg/kg	0.05	0.1	1.64485	1.28155
Hexane	2	0.00153868 mg/kg	44000 mg/kg	0.05	0.1	1.64485	1.28155
Lead	2	7.70564 mg/kg	491.435 mg/kg	0.05	0.1	1.64485	1.28155
Manganese	2	146.86 mg/kg	13857.9 mg/kg	0.05	0.1	1.64485	1.28155
Mercury	2	0.0182741 mg/kg	33.9845 mg/kg	0.05	0.1	1.64485	1.28155
Methyl ethyl ketone	2	0.0207644 mg/kg	440000 mg/kg	0.05	0.1	1.64485	1.28155
Methylene chloride	2	0.00286889 mg/kg	7299.99 mg/kg	0.05	0.1	1.64485	1.28155
Nickel	2	4.87105 mg/kg	1396.09 mg/kg	0.05	0.1	1.64485	1.28155
Selenium	2	0.384345 mg/kg	2699.71 mg/kg	0.05	0.1	1.64485	1.28155
Silver	2	0.246449 mg/kg	349.869 mg/kg	0.05	0.1	1.64485	1.28155
Toluene	2	0.00557446 mg/kg	59000 mg/kg	0.05	0.1	1.64485	1.28155
Vanadium	2	12.2786 mg/kg	319.752 mg/kg	0.05	0.1	1.64485	1.28155
Zinc	2	227.274 mg/kg	75831.3 mg/kg	0.05	0.1	1.64485	1.28155
Beryllium	2	0.307158 mg/kg	26.7275 mg/kg	0.05	0.1	1.64485	1.28155

[a] This value is automatically calculated by VSP based upon the user defined value of α.
[b] This value is automatically calculated by VSP based upon the user defined value of β.

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000) for Aluminum, the driving analyte. It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true mean values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at 1-α on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at 1-α. If any of the inputs change, the number of samples that result in the correct curve changes.



Statistical Assumptions

The assumptions associated with the formulas for computing the number of samples are:

1. the sample mean is normally distributed (this happens if the data are roughly symmetric or the sample size is more than 30; for extremely skewed data sets, additional samples may be required for the sample mean to be normally distributed),
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected randomly.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the sample locations were selected using a random process.

Sensitivity Analysis

The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that μ > action level and alpha (%), probability of mistakenly concluding that μ < action level. The following table shows the results of this analysis.

Number of Samples							
AL=76000		α=5		α=10		α=15	
		s=454.548	s=227.274	s=454.548	s=227.274	s=454.548	s=227.274
LBGR=90	β=5	2	2	1	1	1	1
	β=10	2	2	1	1	1	1
	β=15	2	2	1	1	1	1
LBGR=80	β=5	2	2	1	1	1	1
	β=10	2	2	1	1	1	1
	β=15	2	2	1	1	1	1
LBGR=70	β=5	2	2	1	1	1	1

	β=10	2	2	1	1	1	1
	β=15	2	2	1	1	1	1

s = Standard Deviation
LBGR = Lower Bound of Gray Region (% of Action Level)
β = Beta (%), Probability of mistakenly concluding that μ > action level
α = Alpha (%), Probability of mistakenly concluding that μ < action level
AL = Action Level (Threshold)

Cost of Sampling
The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that are based on the number of samples collected and measured. Based on the numbers of samples determined above, the estimated total cost of sampling and analysis at this site is $2,000.00, which averages out to a per sample cost of $1,000.00. The following table summarizes the inputs and resulting cost estimates.

COST INFORMATION			
Cost Details	**Per Analysis**	**Per Sample**	**2 Samples**
Field collection costs		$100.00	$200.00
Analytical costs	$400.00	$400.00	$800.00
Sum of Field & Analytical costs		**$500.00**	**$1,000.00**
Fixed planning and validation costs			$1,000.00
Total cost			**$2,000.00**

Data Analysis for 1_2_4-Trimethylbenzene
The following data points were entered by the user for analysis.

1_2_4-Trimethylbenzene (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00055	0.0006	0.0006	0.0006	0.0006	0.0006	0.000625	0.00065	0.00065	0.00065
10	0.00065	0.00065	0.00065	0.00065	0.00065	0.00065	0.00065	0.00065	0.00065	0.00065
20	0.0007	0.0007	0.0007	0.0007	0.0007	0.00075	0.00075	0.0008	0.00085	0.00085
30	0.0009	0.0009	0.00095	0.001	0.00105	0.00115	0.00125	0.00125	0.0014	0.0015
40	0.0018	0.00275	0.0045	0.0049						

SUMMARY STATISTICS for 1_2_4-Trimethylbenzene	
n	44
Min	0.00055
Max	0.0049
Range	0.00435
Mean	0.0010324
Median	0.0007
Variance	8.1615e-007
StdDev	0.00090341
Std Error	0.00013619
Skewness	3.4257

Interquartile Range				0.0003375				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00055	0.0006	0.0006	0.00065	0.0007	0.0009875	0.00165	0.004063	0.0049

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for 1_2_4-Trimethylbenzene			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.281	3.08	Yes

The test statistic 4.281 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for 1_2_4-Trimethylbenzene	
1	0.0049

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5241
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

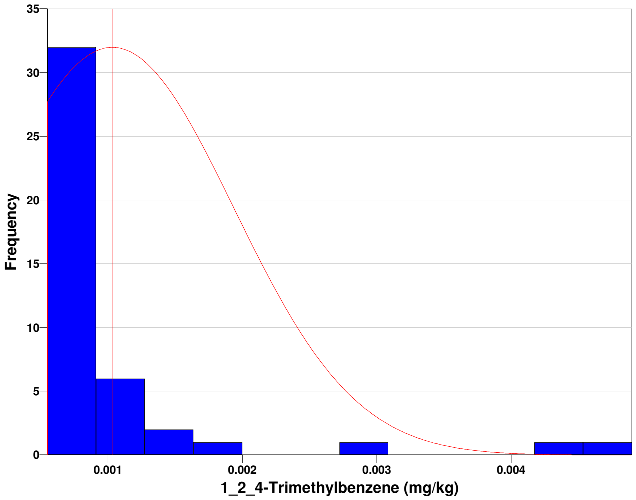
Data Plots for 1_2_4-Trimethylbenzene
Graphical displays of the data are shown below.

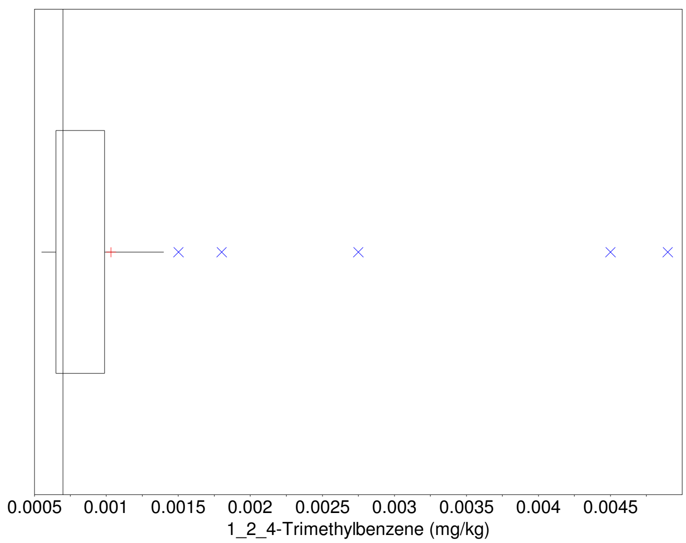
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

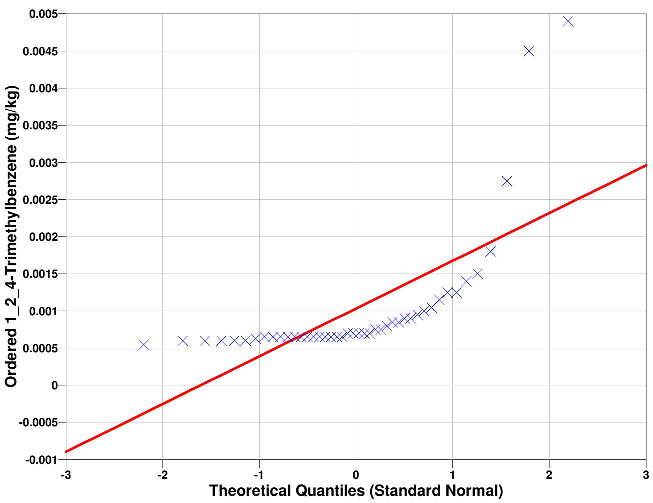
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends

to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for 1_2_4-Trimethylbenzene
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5053
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.001261
95% Non-Parametric (Chebyshev) UCL	0.001626

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.001626) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (76000),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-2.7167e+008	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Acetone
The following data points were entered by the user for analysis.

Acetone (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0036	0.0037	0.00385	0.004	0.004	0.0041	0.0041	0.0042	0.0042	0.0042
10	0.00425	0.0043	0.0043	0.00455	0.00465	0.0048	0.0065	0.0082	0.0092	0.0111

20	0.0112	0.0135	0.0173	0.0189	0.0196	0.0265	0.0336	0.0436	0.048	0.0492
30	0.0499	0.0562	0.0659	0.0698	0.0722	0.088	0.107	0.123	0.128	0.15
40	0.151	0.174	0.18	0.668						

SUMMARY STATISTICS for Acetone								
n	44							
Min	0.0036							
Max	0.668							
Range	0.6644							
Mean	0.05605							
Median	0.0154							
Variance	0.011562							
StdDev	0.10753							
Std Error	0.01621							
Skewness	4.5508							
Interquartile Range	0.064562							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0036	0.003738	0.004	0.004263	0.0154	0.06882	0.1505	0.1785	0.668

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Acetone			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.691	3.08	Yes

The test statistic 5.691 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Acetone	
1	0.668

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)

Shapiro-Wilk Test Statistic	0.7465
Shapiro-Wilk 5% Critical Value	0.943

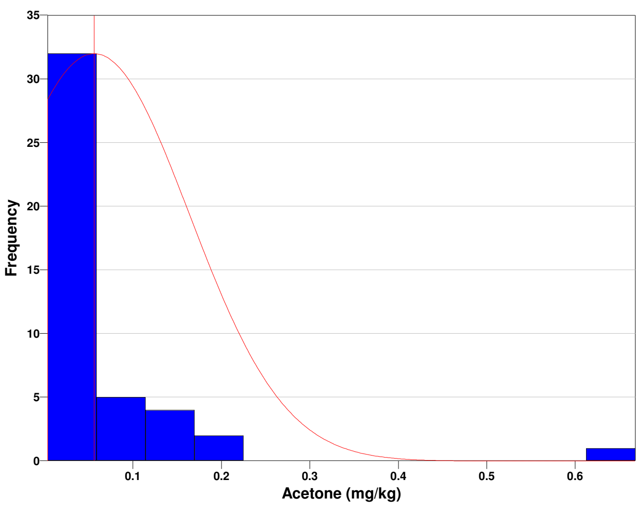
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

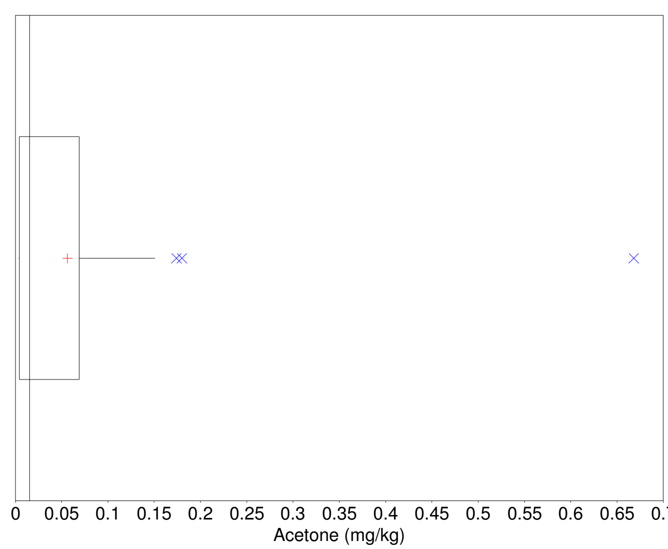
Data Plots for Acetone
Graphical displays of the data are shown below.

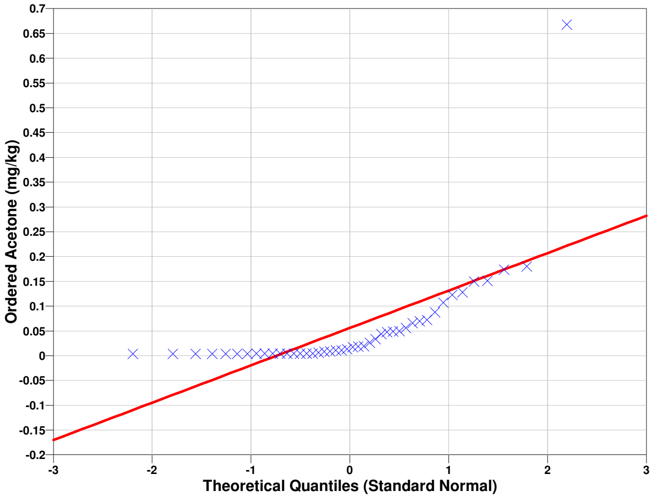
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Acetone
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5093
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.0833
95% Non-Parametric (Chebyshev) UCL	0.1267

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.1267) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (76000),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-4.0715e+007	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Aluminum
The following data points were entered by the user for analysis.

Aluminum (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	953	971	1080	1180	1210	1490	1670	1790	1900	1960
10	2010	2060	2060	2180	2220	2240	2330	2390	2600	2750
20	2860	2860	2870	3810	4290	4560	4660	5000	5490	5590
30	5620	6170	6530	1.03e+004	1.04e+004	1.09e+004	1.17e+004	1.23e+004	1.34e+004	1.45e+004
40	1.89e+004	2.31e+004	3.47e+004	3.59e+004						

SUMMARY STATISTICS for Aluminum								
n	44							
Min	953							
Max	35900							
Range	34947							
Mean	6669.4							
Median	2865							
Variance	6.5361e+007							
StdDev	8084.6							
Std Error	1218.8							
Skewness	2.3968							
Interquartile Range	7335							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
953	998.3	1195	2023	2865	9358	1.67e+004	3.18e+004	3.59e+004

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Aluminum			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.616	3.08	Yes

The test statistic 3.616 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Aluminum	
1	35900

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7062
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

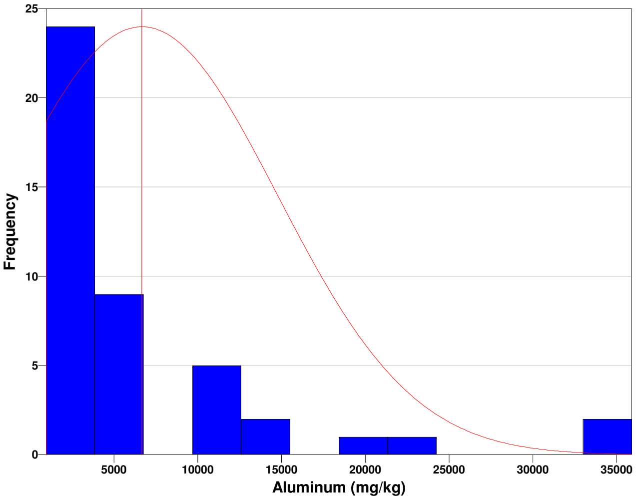
Data Plots for Aluminum
Graphical displays of the data are shown below.

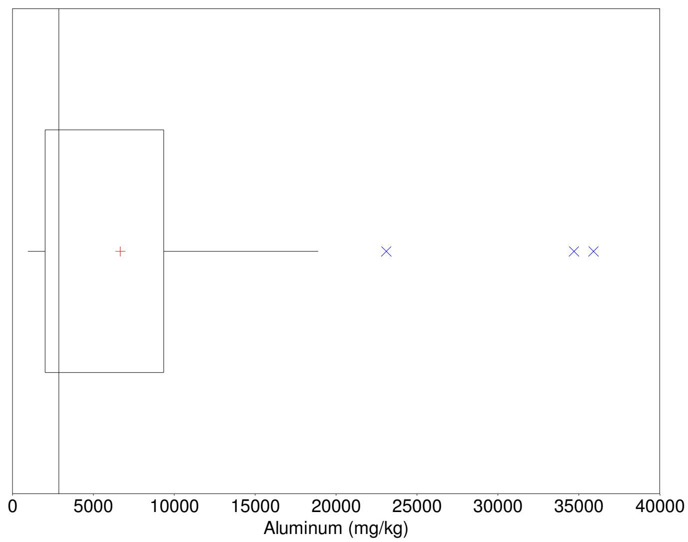
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

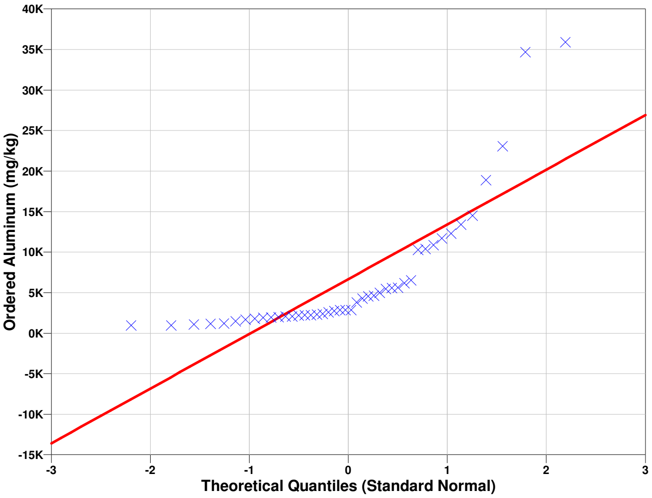
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the

Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Aluminum

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6759
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	8718
95% Non-Parametric (Chebyshev) UCL	1.198e+004

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (1.198e+004) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (76000),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-117.6	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Arsenic
The following data points were entered by the user for analysis.

Arsenic (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.31	0.33	0.43	0.45	0.455	0.625	0.67	0.74	0.75	0.75
10	0.79	0.86	0.86	1.1	1.3	1.3	1.4	1.4	1.4	1.5
20	1.5	1.5	1.6	1.6	1.6	1.7	1.7	2.13	2.2	2.3
30	2.4	2.4	2.6	2.8	2.8	3.3	4.7	4.8	5	6.3
40	6.3	6.5	8.9	17.3						

SUMMARY STATISTICS for Arsenic	
n	44

Min				0.31				
Max				17.3				
Range				16.99				
Mean				2.5307				
Median				1.55				
Variance				8.9321				
StdDev				2.9887				
Std Error				0.45056				
Skewness				3.2631				
Interquartile Range				1.9425				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.31	0.355	0.4525	0.8075	1.55	2.75	6.3	8.3	17.3

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Arsenic			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.942	3.08	Yes

The test statistic 4.942 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Arsenic	
1	17.3

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.794
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

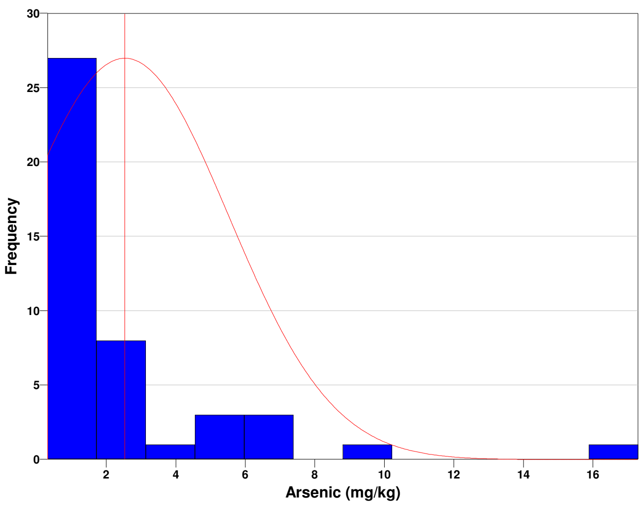
Data Plots for Arsenic

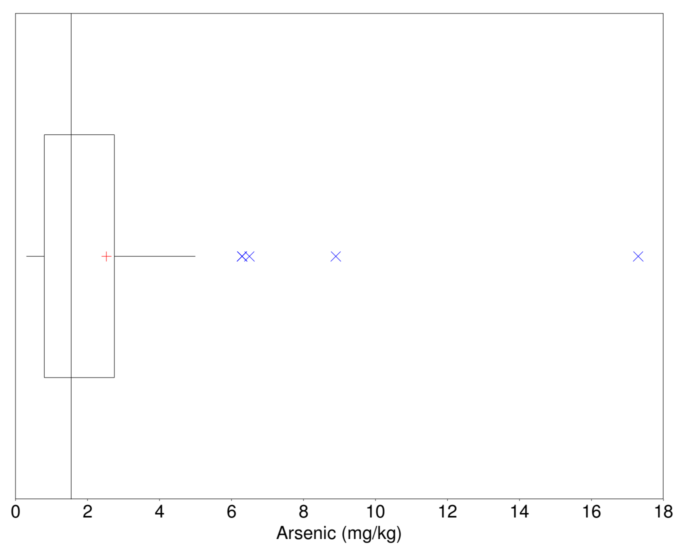
Graphical displays of the data are shown below.

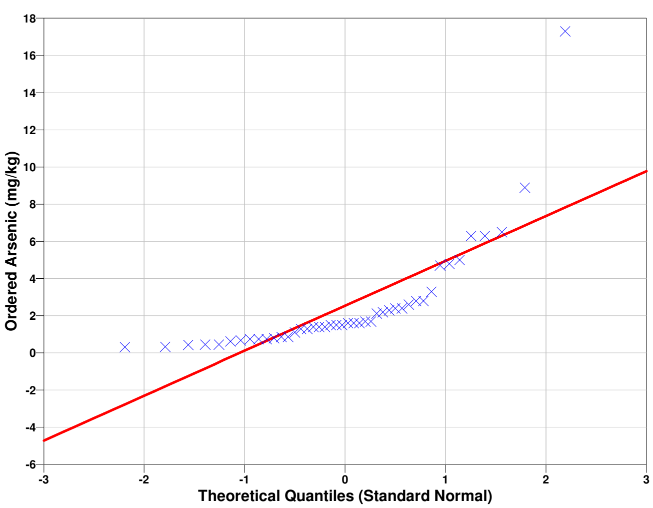
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Arsenic

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6543
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	3.288
95% Non-Parametric (Chebyshev) UCL	4.495

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (4.495) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test

A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where

x is the sample mean of the n=44 data,
AL is the action level or threshold (76000),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-238.53	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**

44	27	Reject

Data Analysis for Barium
The following data points were entered by the user for analysis.

Barium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	7.8	10.4	22.8	22.8	23.1	24.3	25.8	29.2	34.4	36.8
10	45.1	47.4	47.8	48.4	62.5	63.9	66.2	67.1	68.4	71.6
20	72.4	78.5	80.9	89	90.5	94	95.2	118	133	134
30	174	176	209	211	277	308	310	332	343	404
40	471	514	1100	1700						

SUMMARY STATISTICS for Barium								
n	44							
Min	7.8							
Max	1700							
Range	1692.2							
Mean	189.55							
Median	79.7							
Variance	92020							
StdDev	303.35							
Std Error	45.731							
Skewness	3.666							
Interquartile Range	164.82							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
7.8	13.5	22.95	45.67	79.7	210.5	437.5	953.5	1700

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Barium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.979	3.08	Yes

The test statistic 4.979 exceeded the corresponding critical value, therefore that test is significant and we conclude that the

most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Barium	
1	1700

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6749
Shapiro-Wilk 5% Critical Value	0.943

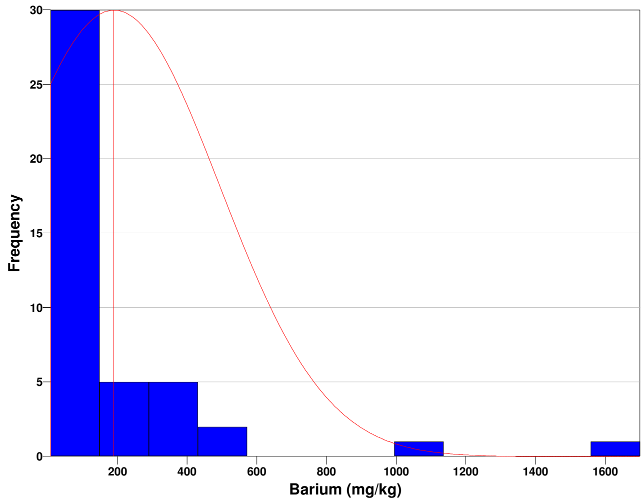
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

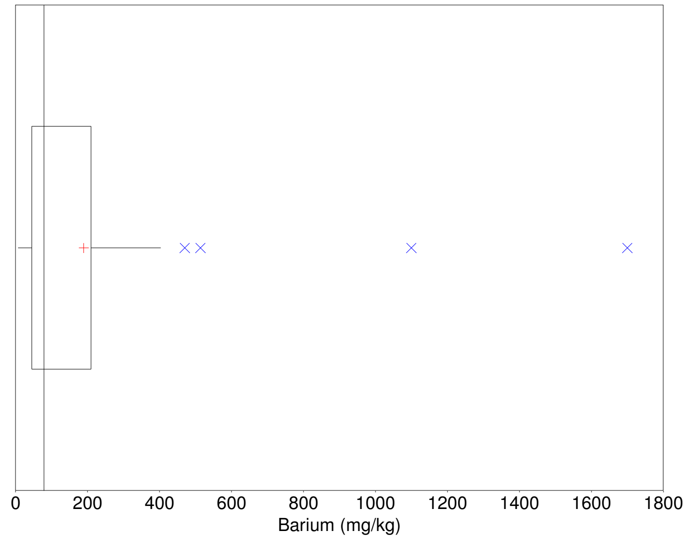
Data Plots for Barium
Graphical displays of the data are shown below.

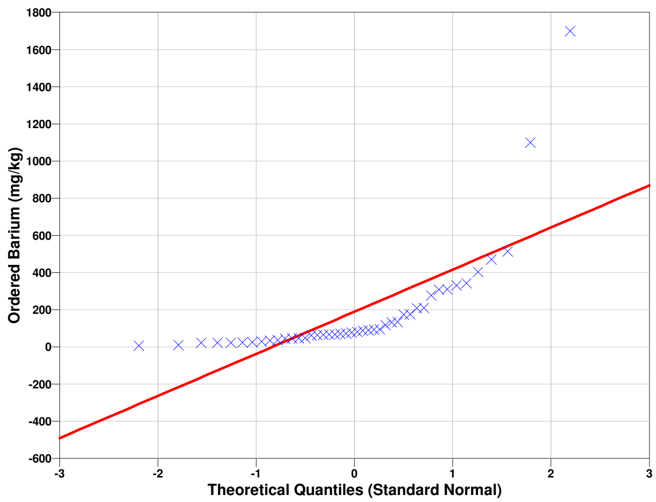
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Barium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5638
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	266.4

95% Non-Parametric (Chebyshev) UCL	388.9

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (388.9) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (76000),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-498.79	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for bis(2-Ethylhexyl)phthalate
The following data points were entered by the user for analysis.

bis(2-Ethylhexyl)phthalate (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.046	0.0465	0.047	0.0479	0.048	0.0483	0.0485	0.0485	0.0485	0.049
10	0.0495	0.0495	0.0498	0.05	0.05	0.05	0.05	0.0525	0.055	0.055
20	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.06	0.06	0.065
30	0.065	0.065	0.065	0.075	0.085	0.095	0.1	0.136	0.153	0.215
40	0.342	0.408	0.444	0.729						

SUMMARY STATISTICS for bis(2-Ethylhexyl)phthalate	
n	44
Min	0.046
Max	0.729

Range				0.683				
Mean				0.1031				
Median				0.055				
Variance				0.017642				
StdDev				0.13282				
Std Error				0.020024				
Skewness				3.3692				
Interquartile Range				0.023				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.046	0.04663	0.04795	0.0495	0.055	0.0725	0.2785	0.435	0.729

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for bis(2-Ethylhexyl)phthalate			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.712	3.08	Yes

The test statistic 4.712 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for bis(2-Ethylhexyl)phthalate	
1	0.729

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.4909
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

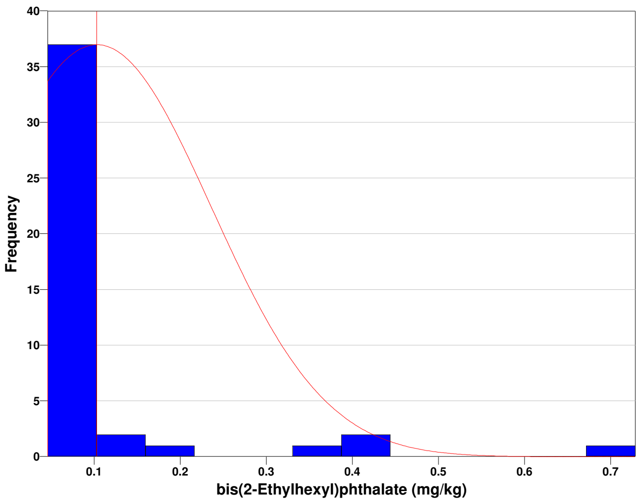
Data Plots for bis(2-Ethylhexyl)phthalate
Graphical displays of the data are shown below.

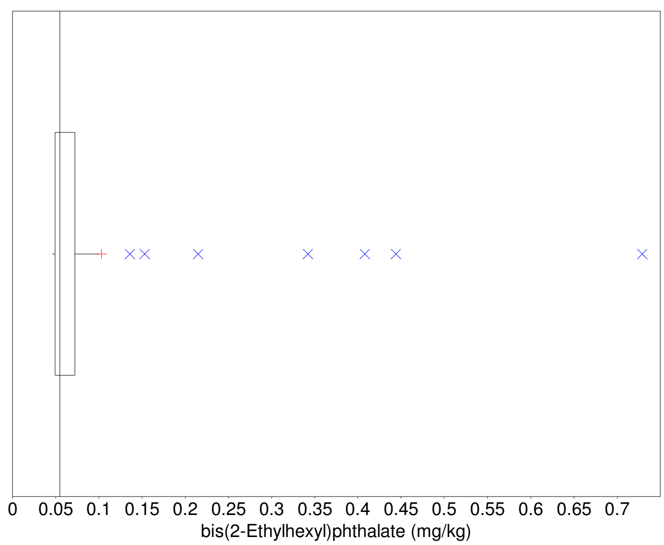
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

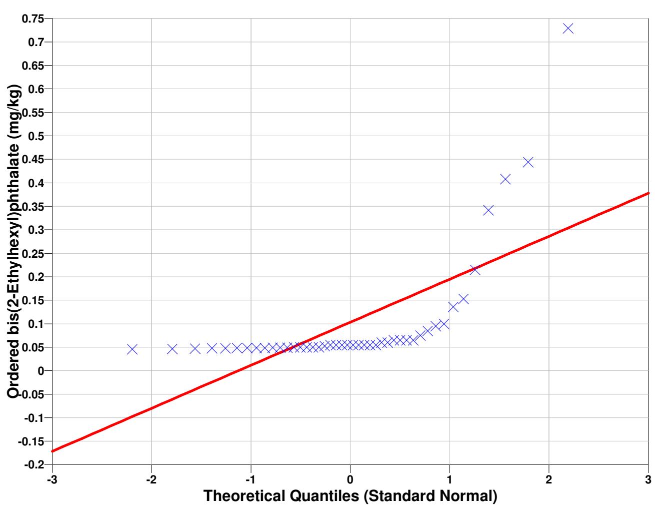
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for bis(2-Ethylhexyl)phthalate
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.4804
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.1368
95% Non-Parametric (Chebyshev) UCL	0.1904

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.1904) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (76000),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-11980	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Cadmium
The following data points were entered by the user for analysis.

Cadmium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0475	0.048	0.05	0.05	0.05	0.05	0.052	0.055	0.055	0.055
10	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.0575
20	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.065	0.065	0.065
30	0.07	0.09	0.115	0.115	0.12	0.2	0.21	0.235	0.25	0.32
40	0.33	0.41	0.48	0.67						

SUMMARY STATISTICS for Cadmium	
n	44
Min	0.0475
Max	0.67
Range	0.6225
Mean	0.12034
Median	0.06
Variance	0.017952
StdDev	0.13398
Std Error	0.020199
Skewness	2.5395
Interquartile Range	0.06

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0475	0.0485	0.05	0.055	0.06	0.115	0.325	0.4625	0.67

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Cadmium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.102	3.08	Yes

The test statistic 4.102 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Cadmium

1	0.67

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6044
Shapiro-Wilk 5% Critical Value	0.943

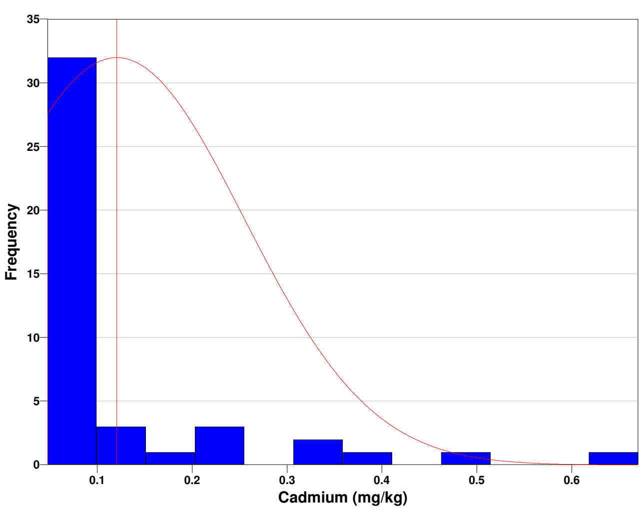
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

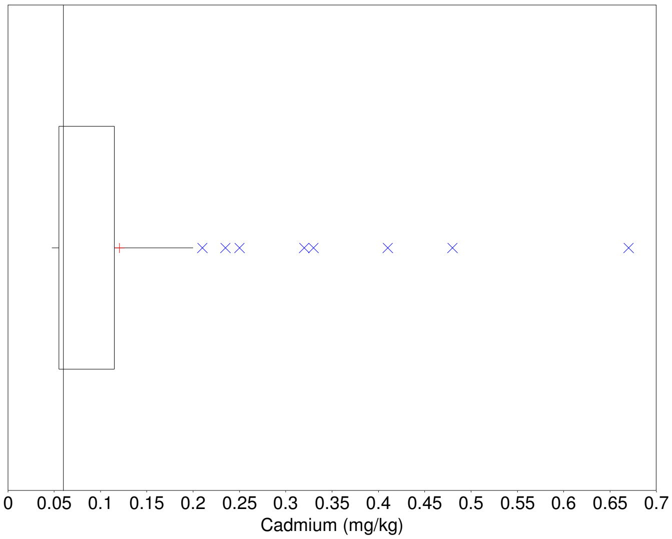
Data Plots for Cadmium
Graphical displays of the data are shown below.

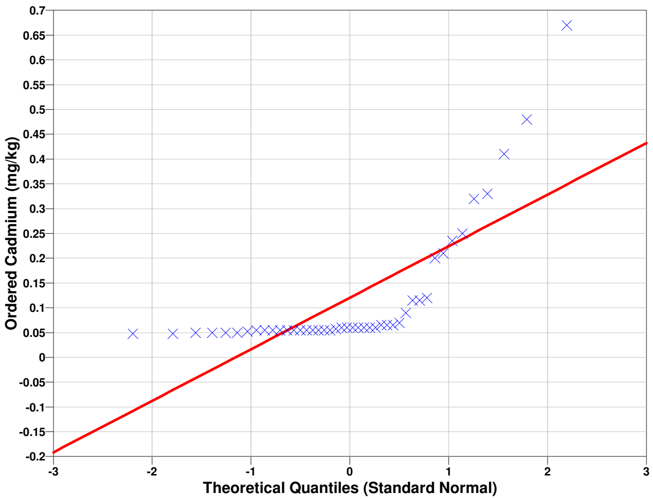
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Cadmium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5927
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.1543

95% Non-Parametric (Chebyshev) UCL	0.2084

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.2084) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (76000),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-54453	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Carbon disulfide
The following data points were entered by the user for analysis.

Carbon disulfide (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00065	0.00065	0.00065	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007
10	0.0007	0.000725	0.000725	0.000725	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075
20	0.00075	0.00075	0.00075	0.0008	0.0008	0.0008	0.0008	0.0008	0.00085	0.0009
30	0.00105	0.0011	0.00115	0.00145	0.0029	0.0032	0.0041	0.0042	0.0048	0.0068
40	0.009	0.0112	0.0139	0.0241						

SUMMARY STATISTICS for Carbon disulfide	
n	44
Min	0.00065
Max	0.0241

Range				0.02345				
Mean				0.0025267				
Median				0.00075				
Variance				1.9633e-005				
StdDev				0.0044309				
Std Error				0.00066799				
Skewness				3.4594				
Interquartile Range				0.00066875				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00065	0.00065	0.0007	0.0007062	0.00075	0.001375	0.0079	0.01322	0.0241

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Carbon disulfide			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.869	3.08	Yes

The test statistic 4.869 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Carbon disulfide	
1	0.0241

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5283
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

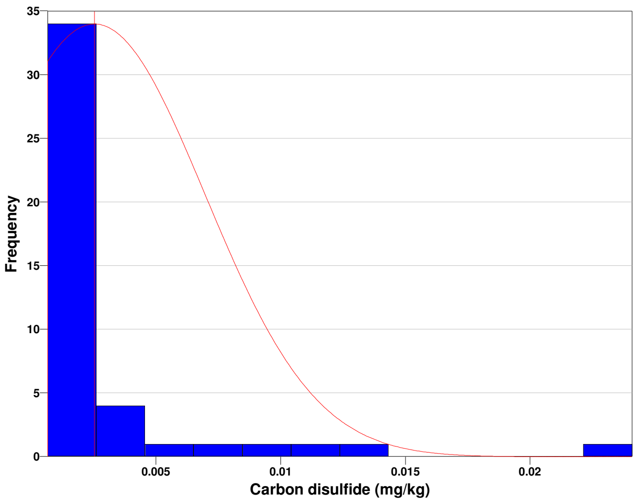
Data Plots for Carbon disulfide
Graphical displays of the data are shown below.

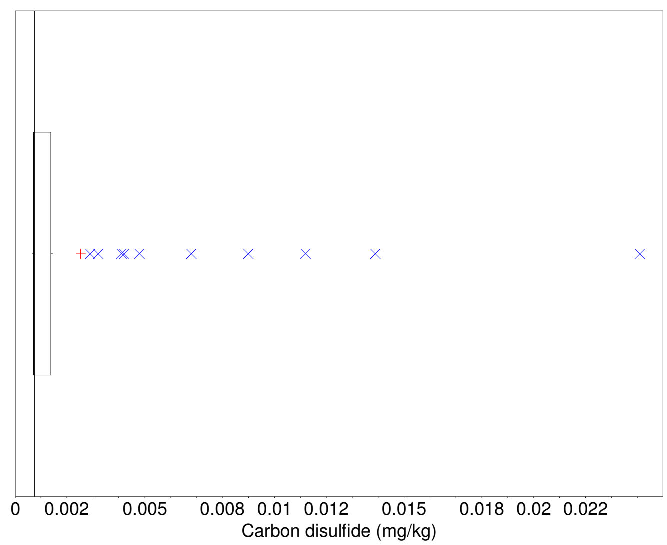
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

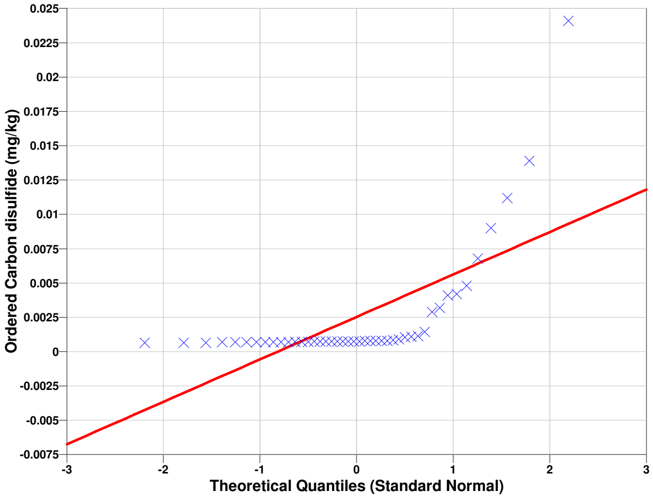
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Carbon disulfide
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.4933
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.00365
95% Non-Parametric (Chebyshev) UCL	0.005438

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.005438) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (76000),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.0928e+008	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Chromium
The following data points were entered by the user for analysis.

Chromium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1.1	1.2	1.2	1.3	1.35	1.6	1.9	2	2	2.1
10	2.2	2.3	2.35	2.4	2.4	2.4	2.4	2.5	2.7	2.9
20	2.9	3.3	3.3	3.3	3.5	4.2	4.2	4.45	4.5	4.7
30	5.7	6.3	7.55	7.6	9.2	9.4	11.8	13.6	14.6	14.9
40	17.4	23.8	28.9	29.9						

SUMMARY STATISTICS for Chromium	
n	44
Min	1.1
Max	29.9
Range	28.8
Mean	6.3477
Median	3.3
Variance	50.753
StdDev	7.1241
Std Error	1.074
Skewness	2.0955
Interquartile Range	5.3625

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
1.1	1.2	1.325	2.225	3.3	7.587	16.15	27.63	29.9

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Chromium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.306	3.08	Yes

The test statistic 3.306 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Chromium

1	29.9

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7122
Shapiro-Wilk 5% Critical Value	0.943

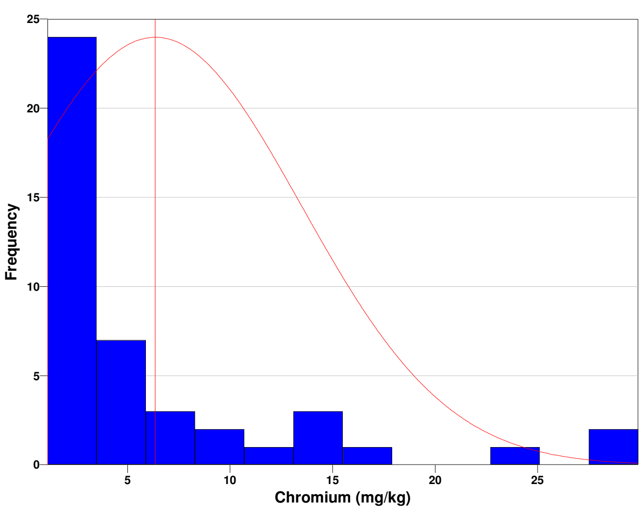
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

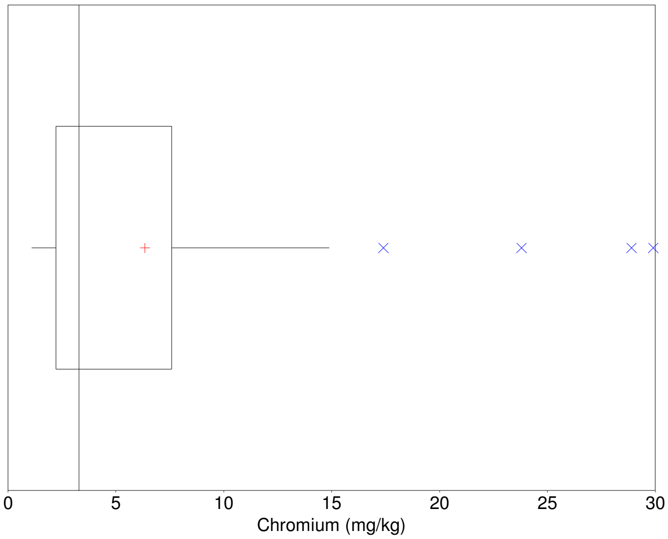
Data Plots for Chromium
Graphical displays of the data are shown below.

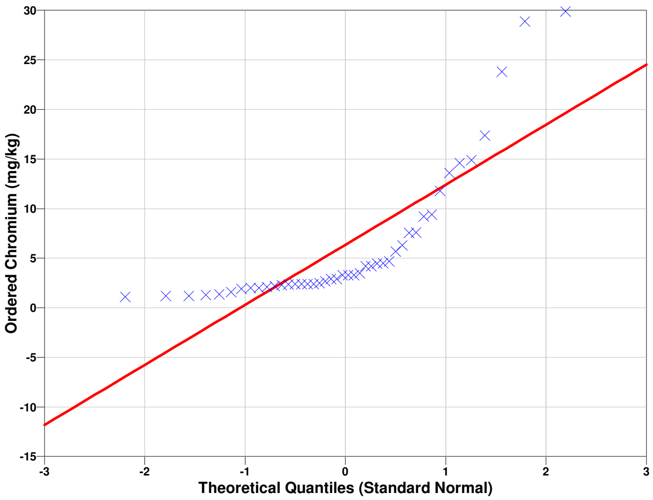
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Chromium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6948
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	8.153

95% Non-Parametric (Chebyshev) UCL	11.03

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (11.03) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (76000),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-33514	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Cobalt
The following data points were entered by the user for analysis.

Cobalt (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.183	0.2	0.22	0.27	0.32	0.34	0.42	0.46	0.52	0.55
10	0.56	0.56	0.57	0.62	0.64	0.67	0.67	0.74	0.79	0.81
20	0.91	0.93	0.95	1.03	1.1	1.15	1.3	1.4	1.4	1.4
30	1.4	1.6	1.72	2.5	2.8	2.8	2.9	3.1	3.2	4.1
40	4.3	5.8	9	10.4						

SUMMARY STATISTICS for Cobalt	
n	44
Min	0.183
Max	10.4

Range	10.217
Mean	1.7569
Median	0.94
Variance	4.6409
StdDev	2.1543
Std Error	0.32477
Skewness	2.646
Interquartile Range	1.745

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.183	0.205	0.295	0.56	0.94	2.305	4.2	8.2	10.4

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Cobalt			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.012	3.08	Yes

The test statistic 4.012 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Cobalt	
1	10.4

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7178
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

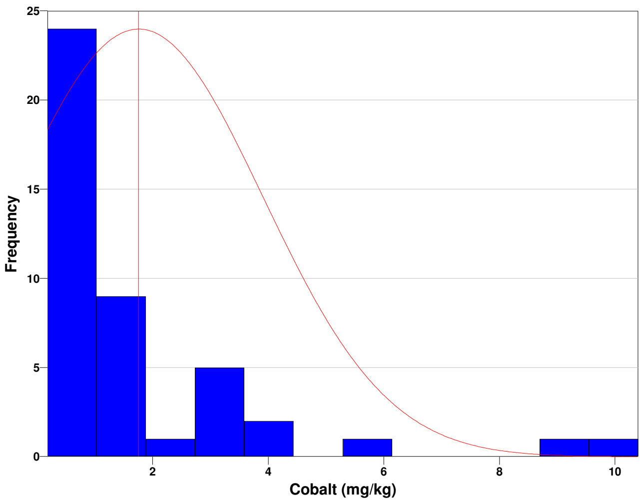
Data Plots for Cobalt
Graphical displays of the data are shown below.

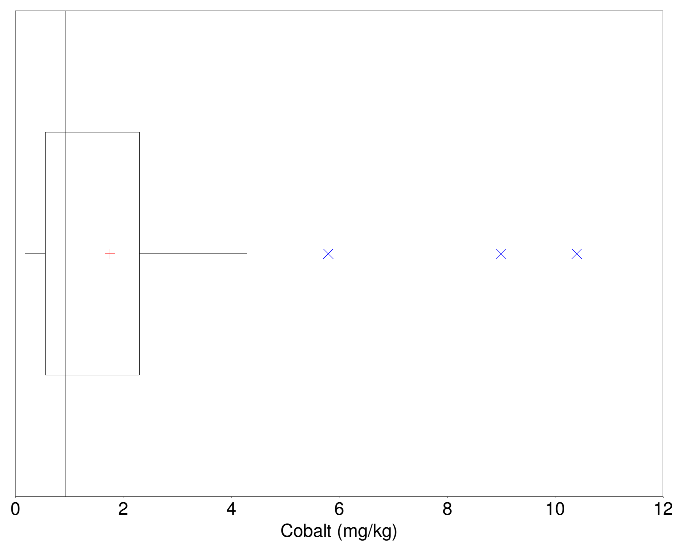
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

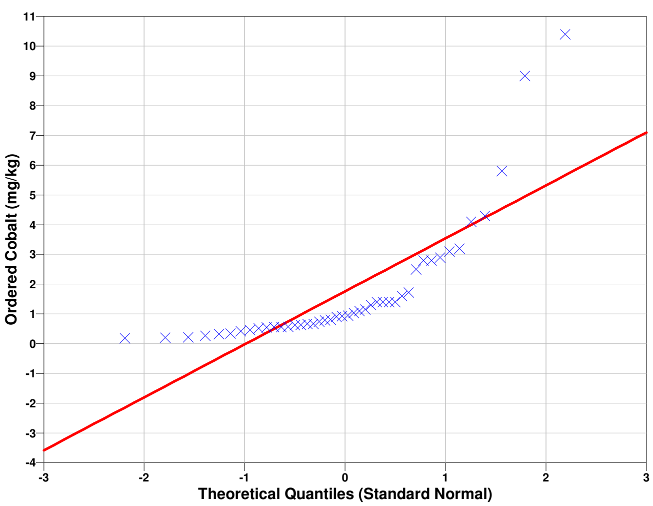
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Cobalt
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6692
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	2.303
95% Non-Parametric (Chebyshev) UCL	3.173

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (3.173) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (76000),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-98526	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Copper
The following data points were entered by the user for analysis.

Copper (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1.1	1.1	1.1	1.1	1.1	1.3	1.5	1.5	1.8	1.9
10	1.9	2.1	2.1	2.2	2.5	2.5	2.5	2.6	2.8	2.8
20	2.9	2.95	3.25	3.3	3.3	3.5	3.6	4.1	4.2	4.4
30	4.6	5.3	7.1	7.7	8	12.1	15.9	19.3	20.7	21.2
40	23	24.9	32.2	57.1						

SUMMARY STATISTICS for Copper	
n	44
Min	1.1
Max	57.1
Range	56
Mean	7.5477
Median	3.1
Variance	116.7
StdDev	10.803
Std Error	1.6286
Skewness	2.8641
Interquartile Range	5.6

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
1.1	1.1	1.1	1.95	3.1	7.55	22.1	30.38	57.1

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Copper			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.587	3.08	Yes

The test statistic 4.587 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Copper

1	57.1

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6764
Shapiro-Wilk 5% Critical Value	0.943

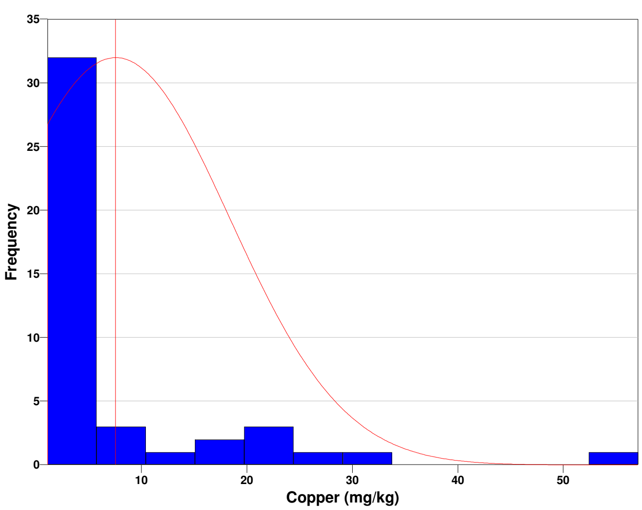
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

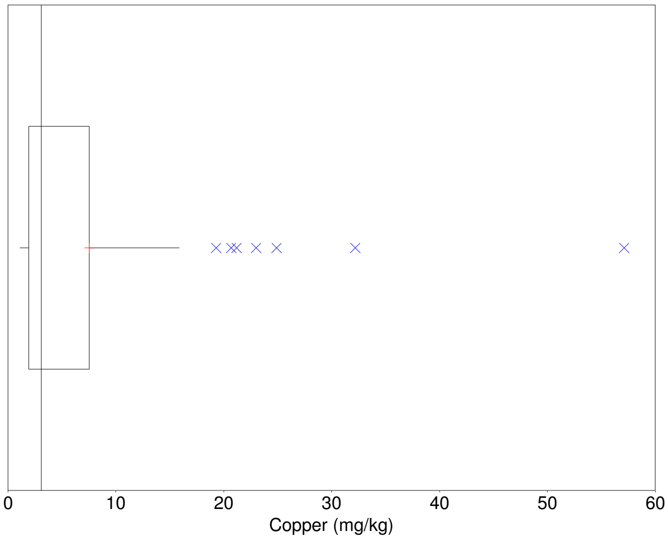
Data Plots for Copper
Graphical displays of the data are shown below.

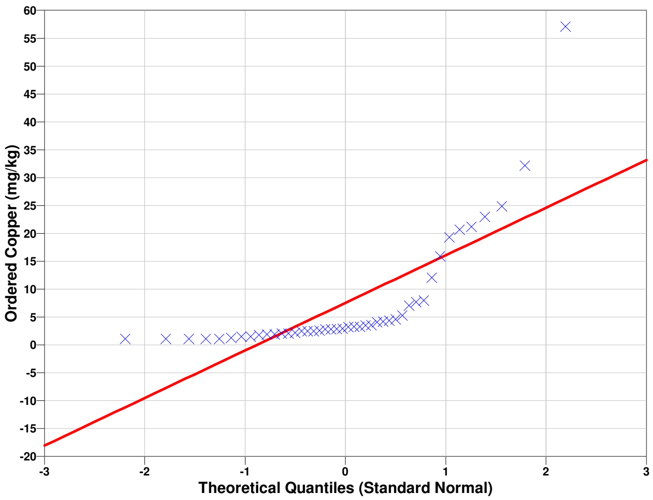
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Copper

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.62
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	10.29

95% Non-Parametric (Chebyshev) UCL	14.65

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (14.65) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (76000),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-12890	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Hexane
The following data points were entered by the user for analysis.

Hexane (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00055	0.00055	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006
10	0.0006	0.0006	0.0006	0.0006	0.000625	0.000625	0.00065	0.00065	0.00065	0.00065
20	0.0007	0.0007	0.0007	0.000725	0.00075	0.0008	0.0008	0.0009	0.00095	0.001
30	0.0011	0.0012	0.0012	0.0013	0.0019	0.0022	0.0022	0.0023	0.0023	0.0026
40	0.0026	0.0033	0.0063	0.0086						

SUMMARY STATISTICS for Hexane	
n	44
Min	0.00055
Max	0.0086

Range				0.00805				
Mean				0.0013472				
Median				0.0007				
Variance				2.3675e-006				
StdDev				0.0015387				
Std Error				0.00023196				
Skewness				3.3948				
Interquartile Range				0.000675				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00055	0.0005625	0.0006	0.0006	0.0007	0.001275	0.0026	0.00555	0.0086

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Hexane			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.714	3.08	Yes

The test statistic 4.714 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Hexane	
1	0.0086

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6129
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

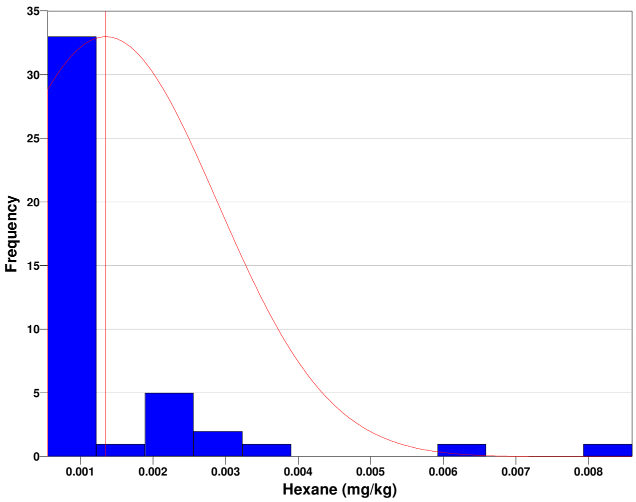
Data Plots for Hexane
Graphical displays of the data are shown below.

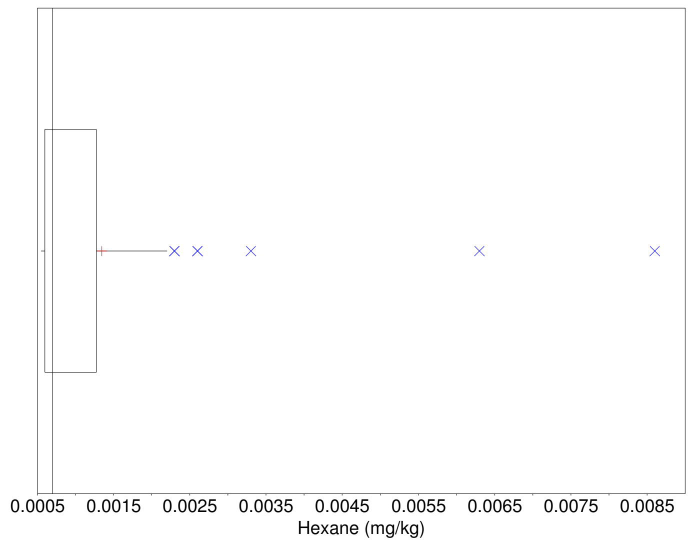
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

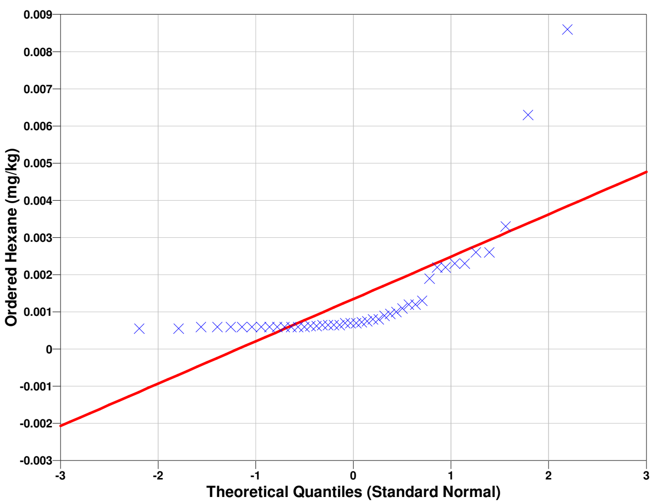
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Hexane
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5497
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.001737
95% Non-Parametric (Chebyshev) UCL	0.002358

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.002358) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (76000),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.8968e+008	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Lead
The following data points were entered by the user for analysis.

Lead (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1.8	2	2.1	2.3	2.4	2.5	2.5	3.1	3.1	3.1
10	3.1	3.55	3.9	4	4	4.2	4.7	4.7	4.7	4.9
20	4.9	5.2	5.4	6.2	6.55	6.7	7.5	7.65	8.1	9.1
30	9.3	9.5	10.6	11.9	12.4	13.5	14	14.1	17.9	17.9
40	18.1	29.1	30.5	34.1						

SUMMARY STATISTICS for Lead	
n	44
Min	1.8
Max	34.1
Range	32.3
Mean	8.5648
Median	5.3
Variance	59.377
StdDev	7.7056
Std Error	1.1617
Skewness	1.8955
Interquartile Range	8.3625

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
1.8	2.025	2.35	3.212	5.3	11.57	18	30.15	34.1

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Lead			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.314	3.08	Yes

The test statistic 3.314 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Lead

1	34.1

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7895
Shapiro-Wilk 5% Critical Value	0.943

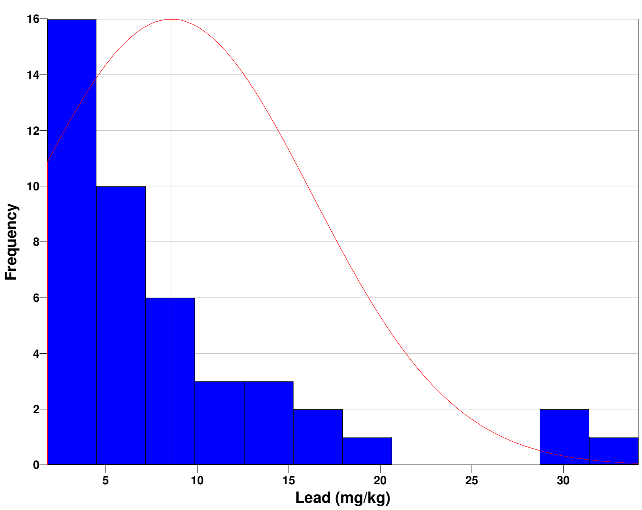
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

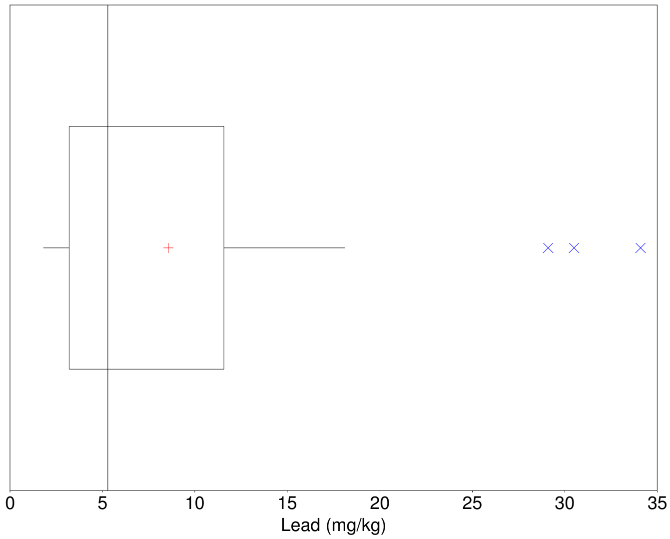
Data Plots for Lead
Graphical displays of the data are shown below.

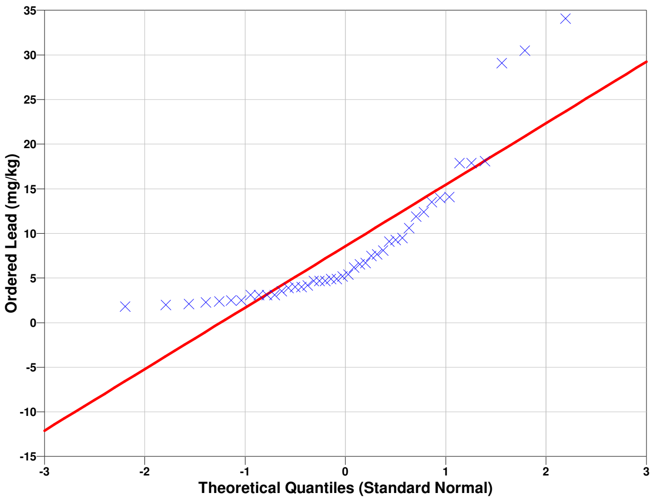
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Lead

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7669
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	10.52

95% Non-Parametric (Chebyshev) UCL	13.63

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (13.63) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (76000),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-423.04	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Manganese
The following data points were entered by the user for analysis.

Manganese (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	9.5	14.1	16.4	17.9	20.2	21.7	32.2	34.7	47.7	49.4
10	54.3	54.9	55.3	58.9	59.8	60	61.1	61.6	65.1	72.3
20	72.7	75	77	79.6	91.5	95.9	97.3	98.1	101	142
30	162	168	171	177	210	241	270	304	352	398
40	427	483	504	588						

SUMMARY STATISTICS for Manganese	
n	44
Min	9.5
Max	588

Range				578.5				
Mean				142.1				
Median				76				
Variance				21567				
StdDev				146.86				
Std Error				22.14				
Skewness				1.6098				
Interquartile Range				121.05				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
9.5	14.67	19.05	54.45	76	175.5	412.5	498.8	588

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Manganese			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.036	3.08	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7771
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

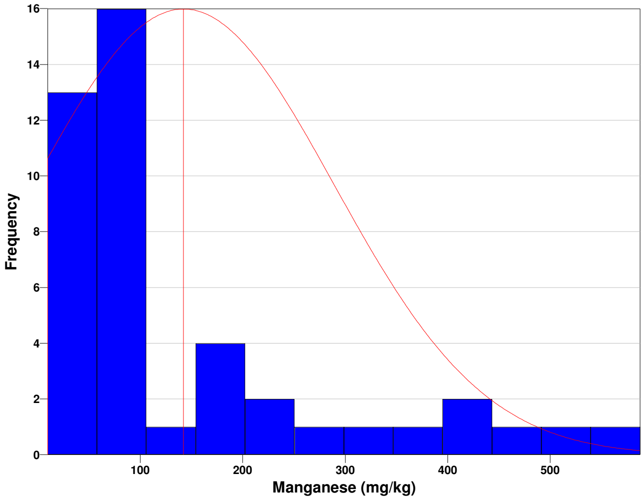
Data Plots for Manganese
Graphical displays of the data are shown below.

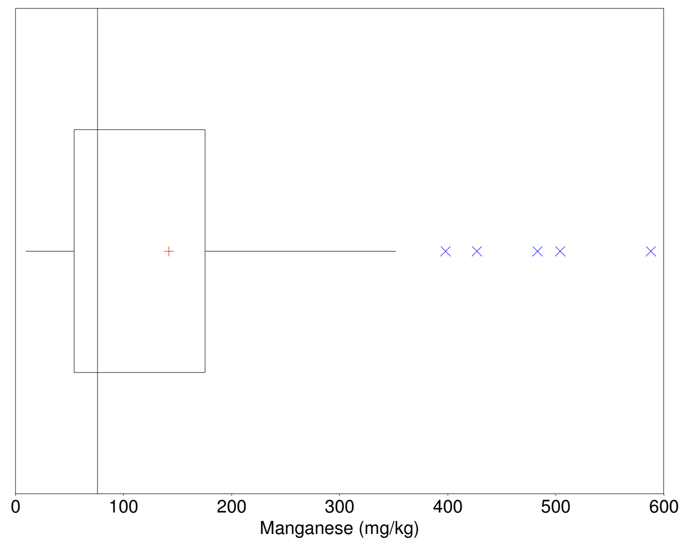
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally

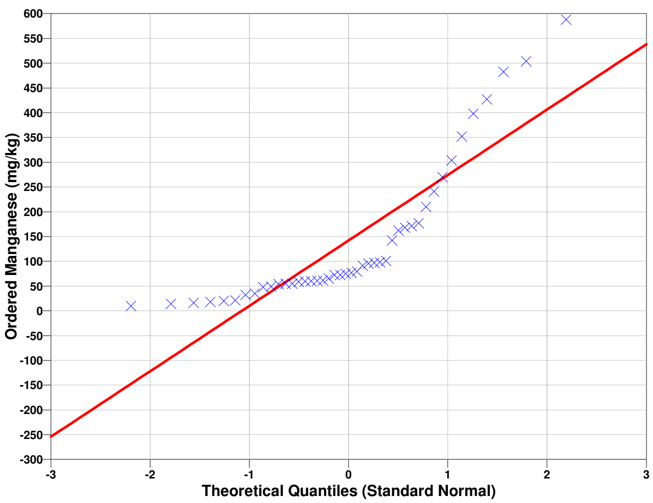
distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Manganese

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was

conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7714
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	179.3
95% Non-Parametric (Chebyshev) UCL	238.6

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (238.6) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (76000),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-625.93	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Mercury
The following data points were entered by the user for analysis.

Mercury (mg/kg)

Rank	1	2	3	4	5	6	7	8	9	10
0	0.000375	0.000385	0.00041	0.0019	0.0021	0.0029	0.00335	0.0034	0.0034	0.0037
10	0.004	0.0047	0.0051	0.0051	0.0061	0.0068	0.0071	0.0072	0.00725	0.0081
20	0.0085	0.0097	0.011	0.011	0.014	0.015	0.015	0.015	0.015	0.018
30	0.018	0.019	0.021	0.021	0.022	0.025	0.027	0.029	0.031	0.032
40	0.033	0.034	0.046	0.11						

SUMMARY STATISTICS for Mercury								
n	44							
Min	0.000375							
Max	0.11							
Range	0.10963							
Mean	0.015536							
Median	0.01035							
Variance	0.00033394							
StdDev	0.018274							
Std Error	0.0027549							
Skewness	3.4436							
Interquartile Range	0.016825							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.000375	0.0003913	0.002	0.004175	0.01035	0.021	0.0325	0.043	0.11

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Mercury			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.169	3.08	Yes

The test statistic 5.169 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Mercury	
1	0.11

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the

suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8976
Shapiro-Wilk 5% Critical Value	0.943

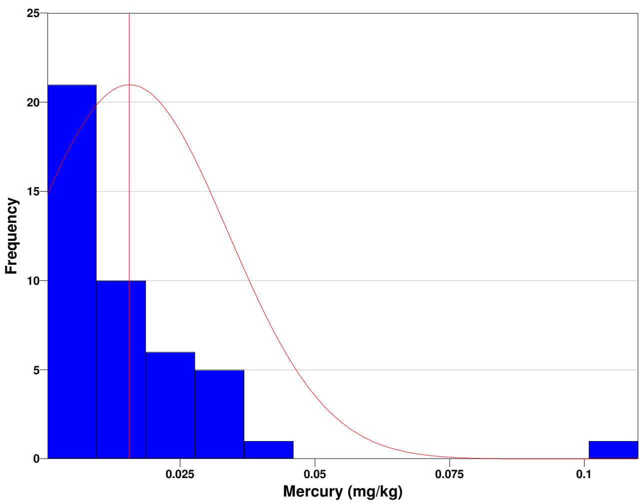
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

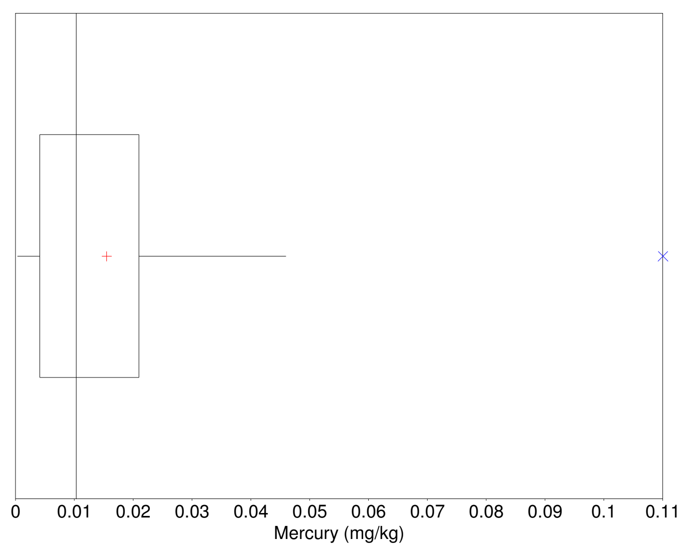
Data Plots for Mercury
Graphical displays of the data are shown below.

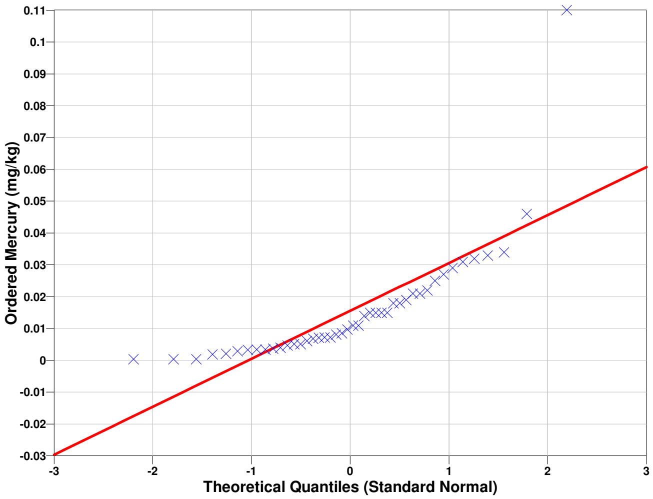
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Mercury
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6841
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.02017
95% Non-Parametric (Chebyshev) UCL	0.02754

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.02754) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (76000),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-12336	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Methyl ethyl ketone
The following data points were entered by the user for analysis.

Methyl ethyl ketone (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00335	0.00345	0.00355	0.00365	0.00365	0.00375	0.00375	0.00375	0.0038	0.00383
10	0.00385	0.00385	0.00385	0.0039	0.00395	0.00395	0.00395	0.00398	0.004	0.004
20	0.00405	0.00405	0.0041	0.00415	0.00415	0.00425	0.00435	0.0045	0.0047	0.005
30	0.0055	0.006	0.0075	0.01	0.0119	0.0154	0.0165	0.0182	0.0255	0.026
40	0.0264	0.029	0.0336	0.135						

SUMMARY STATISTICS for Methyl ethyl ketone								
n	44							
Min	0.00335							
Max	0.135							
Range	0.13165							
Mean	0.011037							
Median	0.004075							
Variance	0.00043116							
StdDev	0.020764							
Std Error	0.0031303							
Skewness	5.2299							
Interquartile Range	0.005525							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00335	0.003475	0.00365	0.00385	0.004075	0.009375	0.0262	0.03245	0.135

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Methyl ethyl ketone			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.97	3.08	Yes

The test statistic 5.97 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Methyl ethyl ketone	
1	0.135

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6085
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

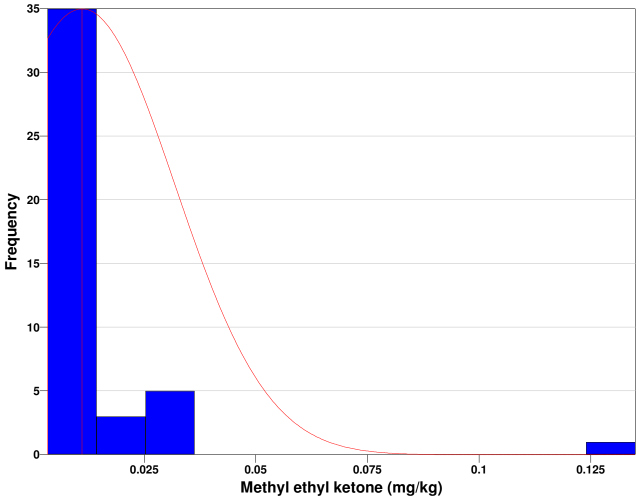
Data Plots for Methyl ethyl ketone
Graphical displays of the data are shown below.

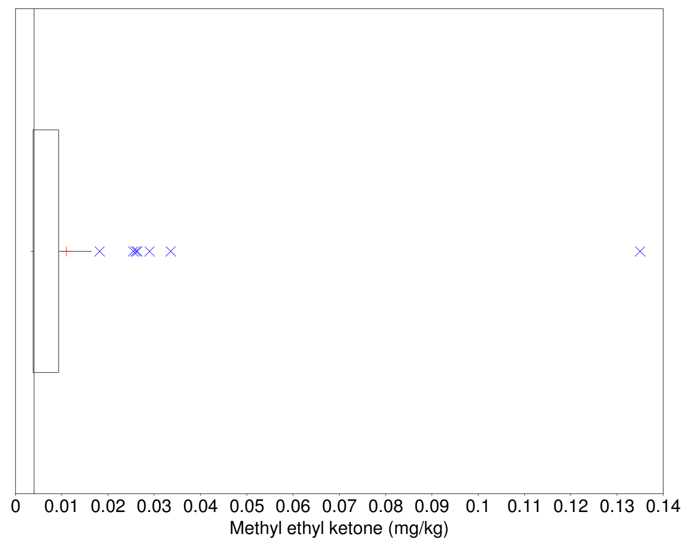
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

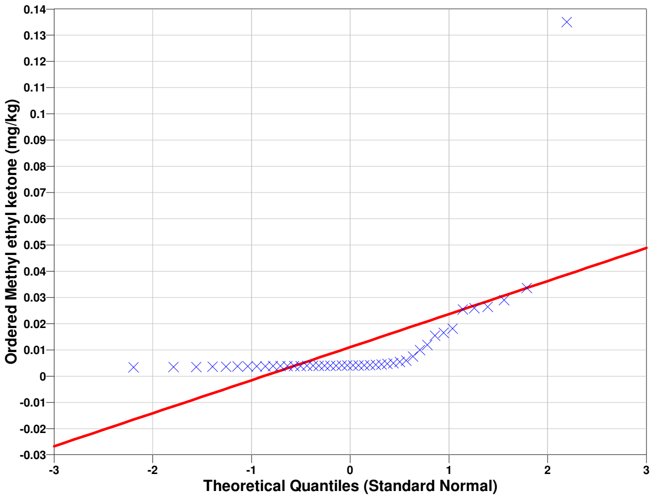
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the

Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Methyl ethyl ketone
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.3933
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.0163
95% Non-Parametric (Chebyshev) UCL	0.02468

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.02468) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (76000),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.4056e+008	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Methylene chloride
The following data points were entered by the user for analysis.

Methylene chloride (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00135	0.0014	0.00143	0.00145	0.00165	0.00225	0.00275	0.0033	0.0036	0.0037
10	0.0037	0.0038	0.004	0.00405	0.0042	0.0042	0.0043	0.0043	0.0043	0.0046
20	0.0047	0.0048	0.0048	0.005	0.0052	0.0054	0.0055	0.0055	0.0057	0.0057
30	0.0057	0.0058	0.0058	0.0059	0.0063	0.0064	0.0064	0.0066	0.0069	0.007
40	0.0071	0.0079	0.008	0.0199						

SUMMARY STATISTICS for Methylene chloride	
n	44

Min				0.00135				
Max				0.0199				
Range				0.01855				
Mean				0.005053				
Median				0.0048				
Variance				8.2297e-006				
StdDev				0.0028687				
Std Error				0.00043248				
Skewness				3.1671				
Interquartile Range				0.00215				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00135	0.001407	0.00155	0.003725	0.0048	0.005875	0.00705	0.007975	0.0199

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Methylene chloride			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.175	3.08	Yes

The test statistic 5.175 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Methylene chloride	
1	0.0199

Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9566
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do appear to follow a normal distribution at the 5% level of significance.

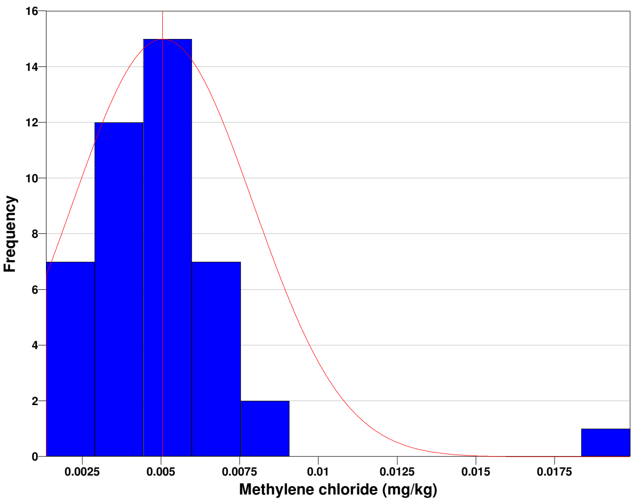
Data Plots for Methylene chloride
Graphical displays of the data are shown below.

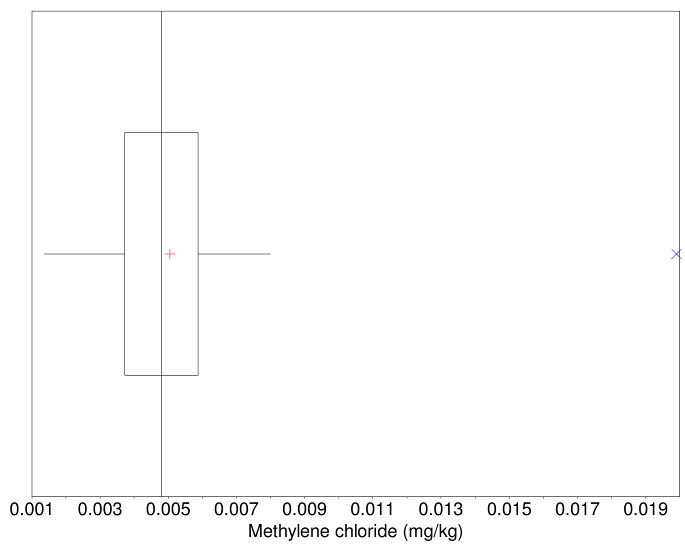
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

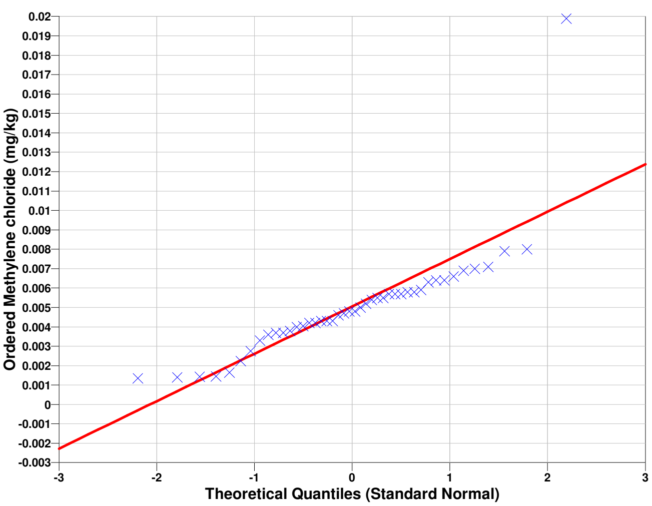
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Methylene chloride
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7343
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.00578
95% Non-Parametric (Chebyshev) UCL	0.006938

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.006938) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (76000),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.6879e+007	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Nickel
The following data points were entered by the user for analysis.

Nickel (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.31	0.47	0.515	0.67	0.72	0.83	0.88	1.1	1.1	1.1
10	1.2	1.3	1.3	1.3	1.35	1.4	1.4	1.4	1.5	1.6
20	1.7	1.8	2.05	2.1	2.1	2.1	2.4	2.45	2.7	2.7
30	2.9	3.1	4.4	4.9	5.4	7.2	8	8.6	8.74	9.4
40	11.4	12.7	18.1	23.5						

SUMMARY STATISTICS for Nickel	
n	44
Min	0.31
Max	23.5
Range	23.19
Mean	3.9065
Median	1.925
Variance	23.728
StdDev	4.8712
Std Error	0.73436
Skewness	2.4111
Interquartile Range	3.55

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.31	0.4812	0.695	1.225	1.925	4.775	10.4	16.75	23.5

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Nickel			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.022	3.08	Yes

The test statistic 4.022 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Nickel

1	23.5

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7223
Shapiro-Wilk 5% Critical Value	0.943

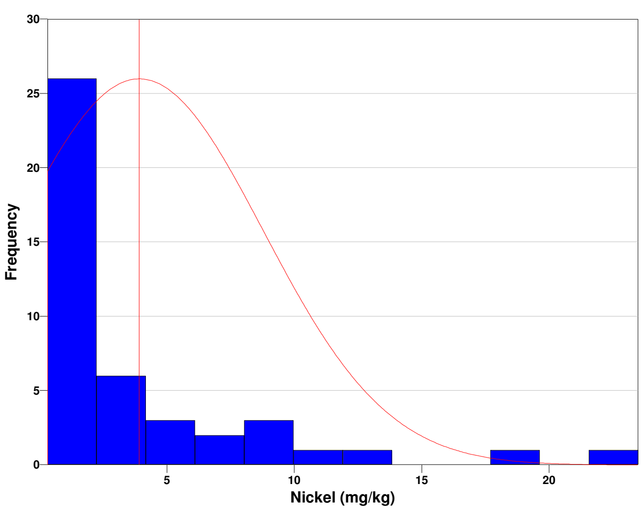
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

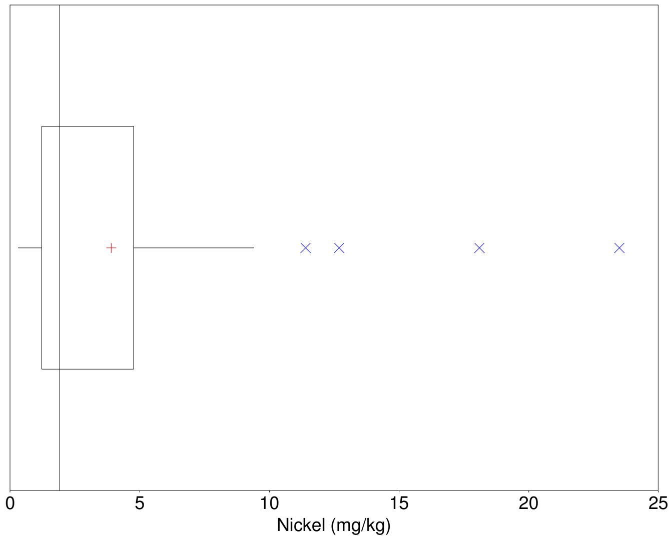
Data Plots for Nickel
Graphical displays of the data are shown below.

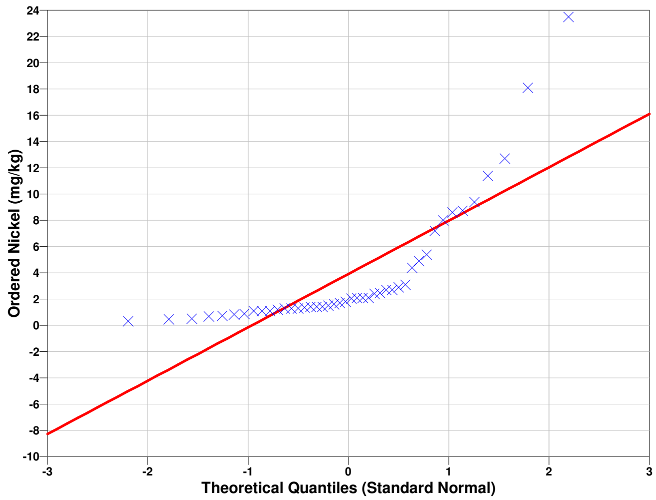
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Nickel

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6815
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	5.141

95% Non-Parametric (Chebyshev) UCL	7.107

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (7.107) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (76000),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1901.1	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Selenium
The following data points were entered by the user for analysis.

Selenium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.115	0.125	0.125	0.125	0.125	0.125	0.128	0.13	0.13	0.13
10	0.13	0.13	0.135	0.135	0.135	0.135	0.135	0.135	0.14	0.14
20	0.14	0.145	0.145	0.15	0.15	0.15	0.155	0.16	0.17	0.19
30	0.21	0.27	0.28	0.28	0.31	0.34	0.34	0.39	0.445	0.47
40	1	1.07	1.2	2.2						

SUMMARY STATISTICS for Selenium	
n	44
Min	0.115
Max	2.2

Range				2.085				
Mean				0.29473				
Median				0.145				
Variance				0.1479				
StdDev				0.38457				
Std Error				0.057977				
Skewness				3.5841				
Interquartile Range				0.15				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.115	0.125	0.125	0.13	0.145	0.28	0.735	1.168	2.2

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Selenium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.954	3.08	Yes

The test statistic 4.954 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Selenium	
1	2.2

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5477
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

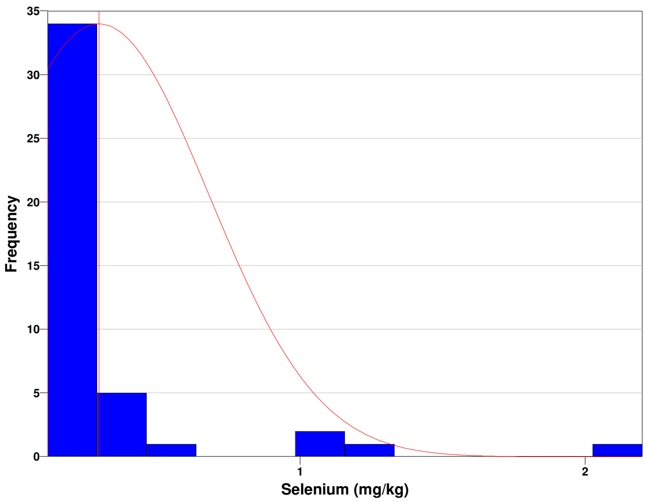
Data Plots for Selenium
Graphical displays of the data are shown below.

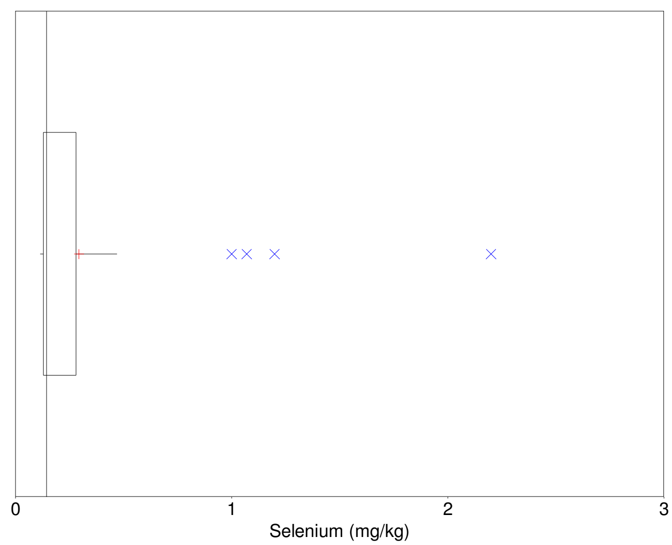
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

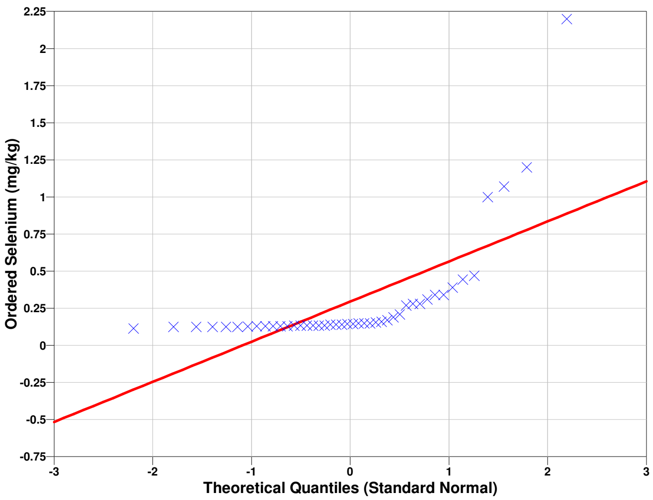
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Selenium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5016
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.3922
95% Non-Parametric (Chebyshev) UCL	0.5474

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.5474) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (76000),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-46565	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Silver
The following data points were entered by the user for analysis.

Silver (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.038	0.041	0.041	0.0415	0.0415	0.042	0.042	0.042	0.0423	0.043
10	0.0435	0.0435	0.044	0.044	0.045	0.045	0.0455	0.0458	0.046	0.046
20	0.0465	0.047	0.0485	0.0485	0.049	0.0495	0.05	0.05	0.055	0.07
30	0.089	0.09	0.093	0.095	0.11	0.12	0.15	0.175	0.24	0.24
40	0.27	0.32	1.1	1.3						

SUMMARY STATISTICS for Silver								
n	44							
Min	0.038							
Max	1.3							
Range	1.262							
Mean	0.1311							
Median	0.04775							
Variance	0.060736							
StdDev	0.24645							
Std Error	0.037153							
Skewness	4.0686							
Interquartile Range	0.051							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.038	0.041	0.0415	0.0435	0.04775	0.0945	0.255	0.905	1.3

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Silver			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.743	3.08	Yes

The test statistic 4.743 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Silver

1	1.3

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.4055
Shapiro-Wilk 5% Critical Value	0.943

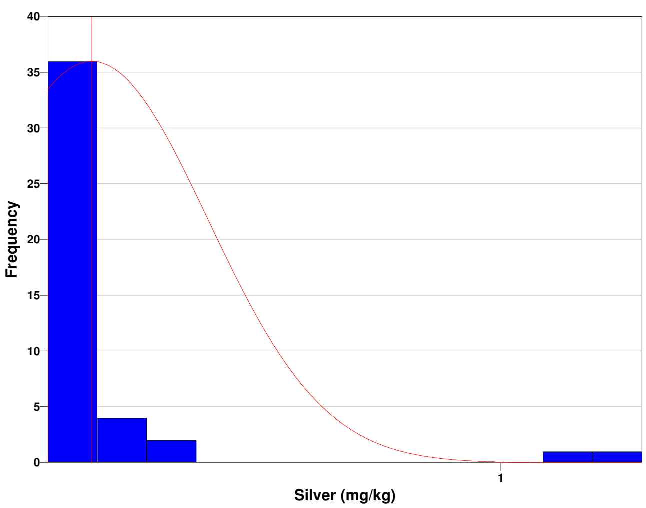
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

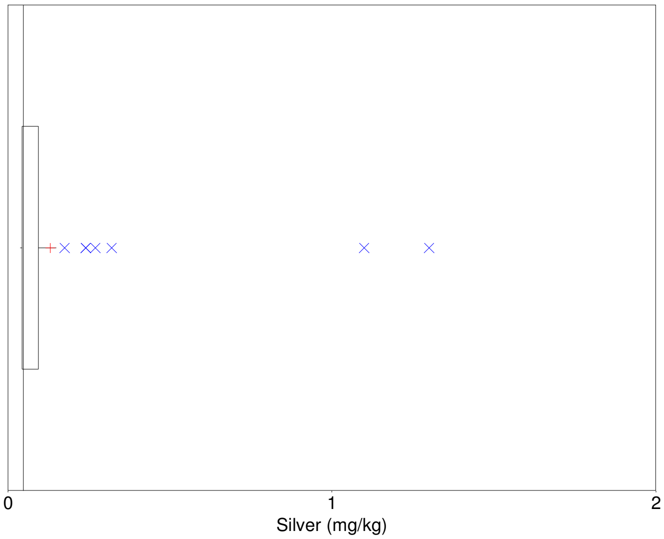
Data Plots for Silver
Graphical displays of the data are shown below.

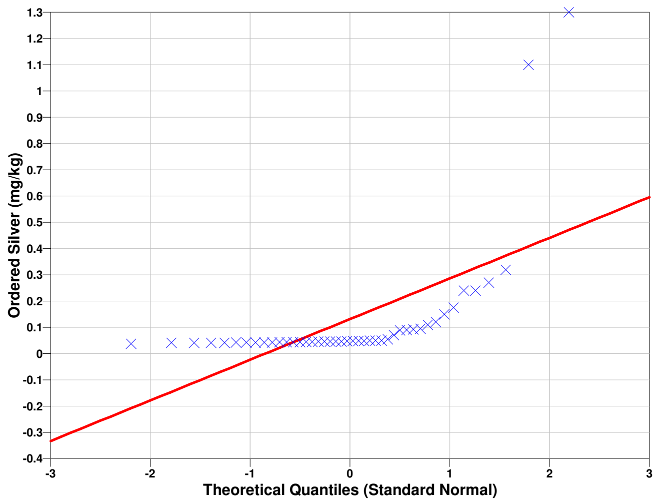
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Silver
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.4041
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.1936

95% Non-Parametric (Chebyshev) UCL	0.2931

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.2931) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (76000),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-9416.9	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Toluene
The following data points were entered by the user for analysis.

Toluene (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00065	0.00065	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007
10	0.000725	0.000725	0.000725	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075
20	0.00075	0.00075	0.00075	0.0008	0.0008	0.0008	0.000825	0.0009	0.0009	0.00095
30	0.001	0.00105	0.00105	0.0011	0.00115	0.0012	0.00145	0.0022	0.0027	0.0031
40	0.00315	0.00415	0.005	0.0376						

SUMMARY STATISTICS for Toluene	
n	44
Min	0.00065
Max	0.0376

Range				0.03695				
Mean				0.0020102				
Median				0.00075				
Variance				3.1075e-005				
StdDev				0.0055745				
Std Error				0.00084038				
Skewness				6.3366				
Interquartile Range				0.0003625				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00065	0.0006625	0.0007	0.000725	0.00075	0.001087	0.003125	0.004788	0.0376

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Toluene			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	6.384	3.08	Yes

The test statistic 6.384 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Toluene	
1	0.0376

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5618
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

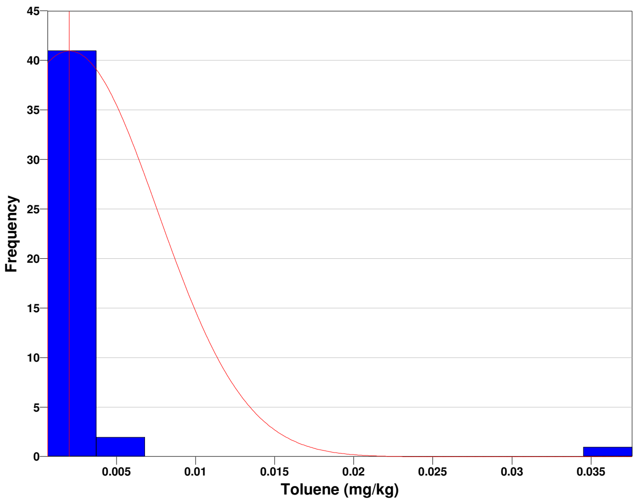
Data Plots for Toluene
Graphical displays of the data are shown below.

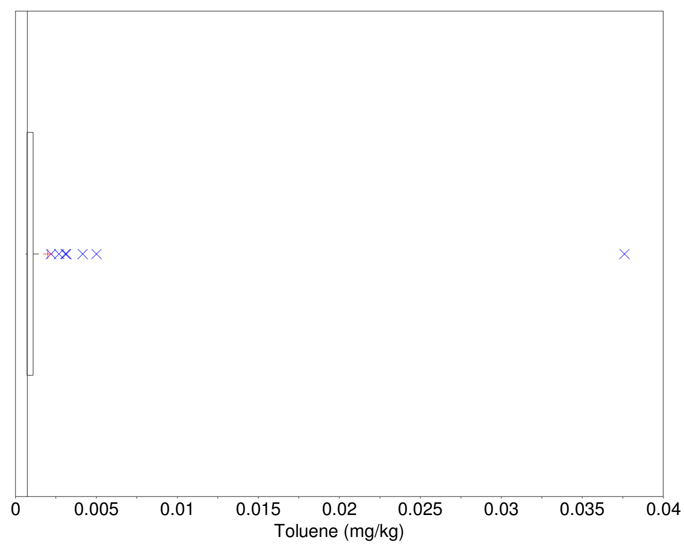
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

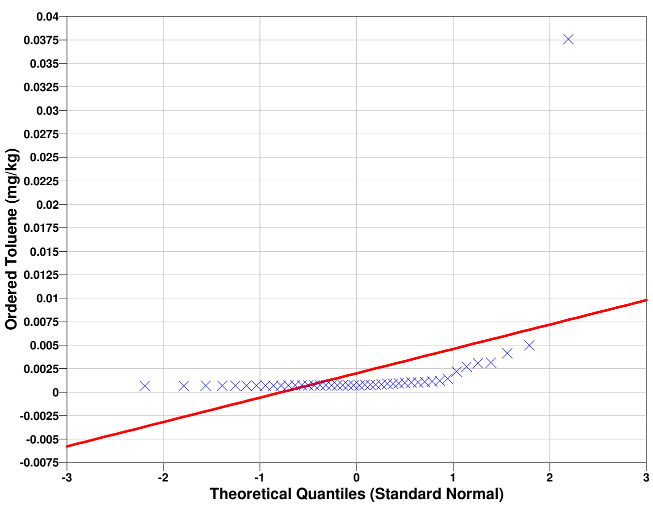
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Toluene
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.247
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.003423
95% Non-Parametric (Chebyshev) UCL	0.005673

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.005673) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (76000),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-7.0206e+007	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Vanadium
The following data points were entered by the user for analysis.

Vanadium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1.2	1.5	1.6	1.65	1.9	2.5	2.65	3	3	3
10	3.5	3.6	3.6	3.8	3.8	3.95	4.1	4.8	4.8	5.1
20	5.4	5.7	6	6.1	6.2	6.4	6.6	6.7	8.2	8.3
30	8.5	9.6	10.3	13.6	16	16.1	16.8	18.8	19.8	20.7
40	25.1	39.9	48.2	58.9						

SUMMARY STATISTICS for Vanadium	
n	44
Min	1.2
Max	58.9
Range	57.7
Mean	10.249
Median	5.85
Variance	150.76
StdDev	12.279
Std Error	1.8511
Skewness	2.5561
Interquartile Range	9.25

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
1.2	1.525	1.775	3.525	5.85	12.78	22.9	46.13	58.9

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Vanadium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.962	3.08	Yes

The test statistic 3.962 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Vanadium

1	58.9

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7103
Shapiro-Wilk 5% Critical Value	0.943

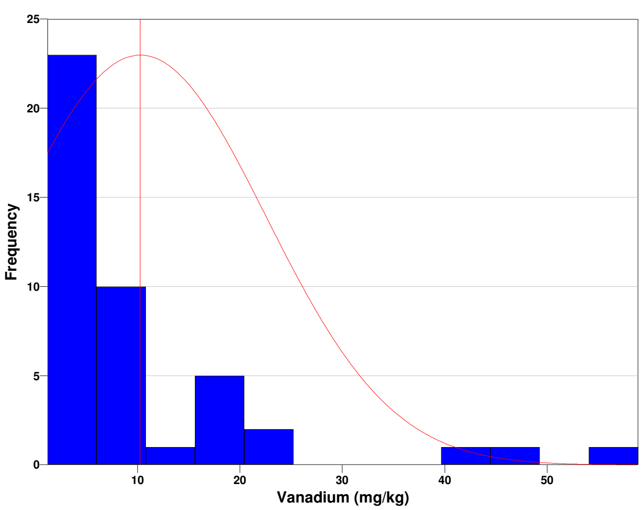
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

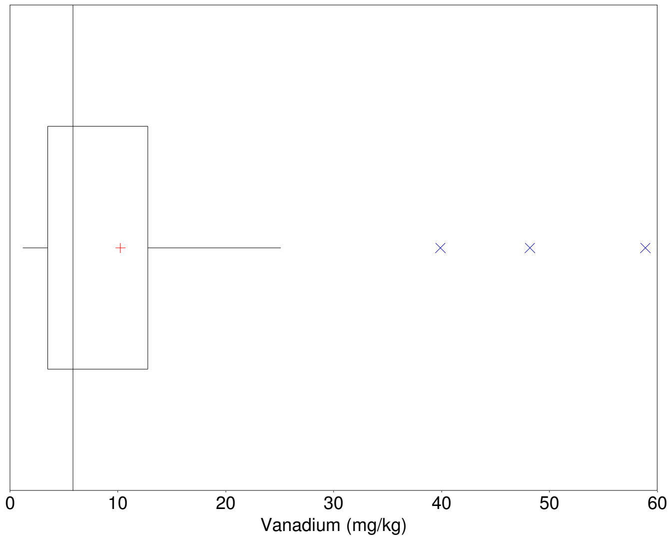
Data Plots for Vanadium
Graphical displays of the data are shown below.

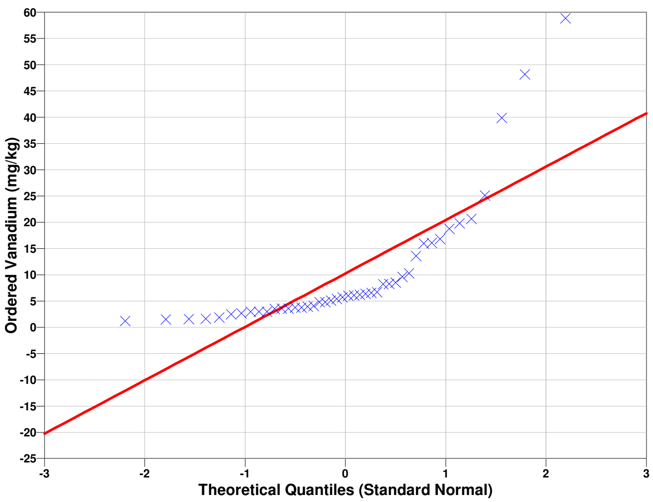
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Vanadium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6711
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	13.36

95% Non-Parametric (Chebyshev) UCL	18.32

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (18.32) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (76000),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-172.74	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Zinc
The following data points were entered by the user for analysis.

Zinc (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	11.2	16.9	17.2	24.7	26.7	27	27.5	29.6	32.25	34.5
10	37.8	37.8	40	42.5	52.3	53.4	58.3	59.8	64.1	68.2
20	86.4	88.2	91.2	91.4	92.55	95.9	96	96.5	104	119
30	122	128	134	187	207	208	257.6	305	463	569
40	611	802	812	896						

SUMMARY STATISTICS for Zinc	
n	44
Min	11.2
Max	896

Range				884.8				
Mean				168.74				
Median				89.7				
Variance				51653				
StdDev				227.27				
Std Error				34.263				
Skewness				2.1447				
Interquartile Range				135.95				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
11.2	16.97	25.7	37.8	89.7	173.8	590	809.5	896

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Zinc			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.2	3.08	Yes

The test statistic 3.2 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Zinc	
1	896

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6485
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

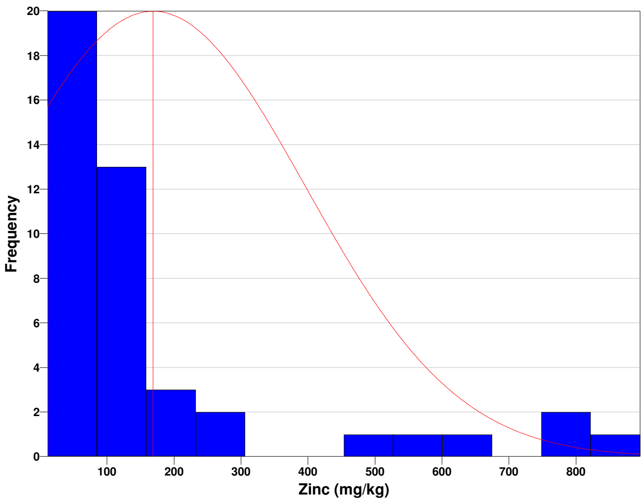
Data Plots for Zinc
Graphical displays of the data are shown below.

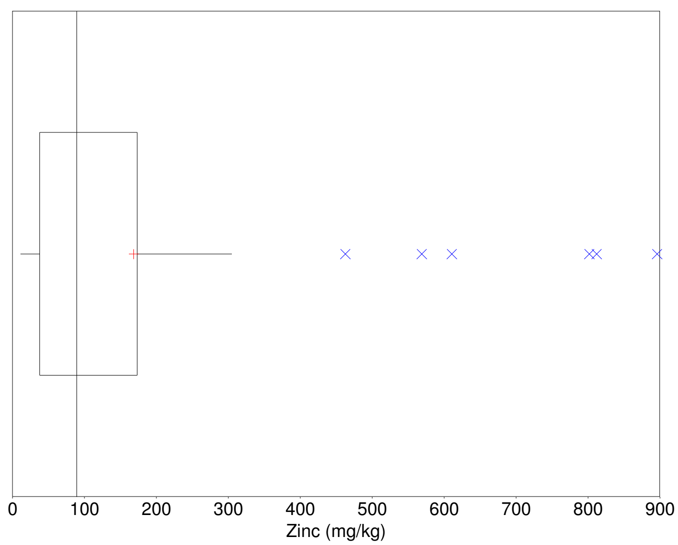
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

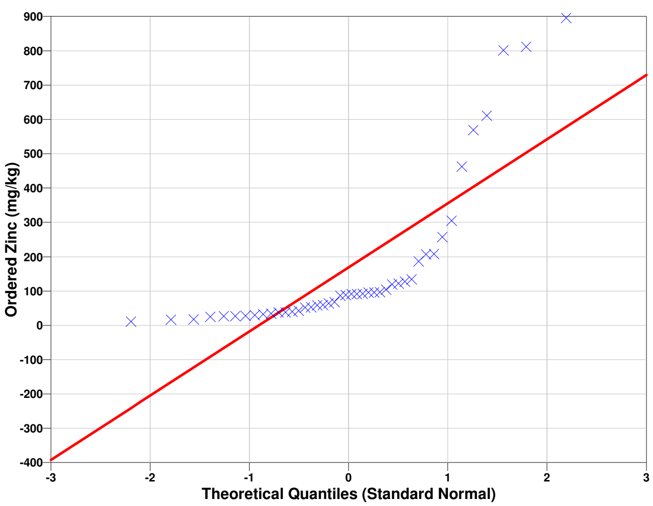
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Zinc
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6493
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	226.3
95% Non-Parametric (Chebyshev) UCL	318.1

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (318.1) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (76000),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-2213.2	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Beryllium
The following data points were entered by the user for analysis.

Beryllium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.051	0.055	0.056	0.058	0.061	0.064	0.091	0.092	0.094	0.096
10	0.0965	0.098	0.1	0.1	0.1	0.11	0.11	0.12	0.125	0.13
20	0.14	0.14	0.15	0.15	0.19	0.19	0.21	0.21	0.21	0.22
30	0.225	0.23	0.257	0.4	0.42	0.43	0.47	0.49	0.52	0.58
40	0.68	0.97	1.3	1.4						

SUMMARY STATISTICS for Beryllium	
n	44
Min	0.051
Max	1.4
Range	1.349
Mean	0.27249
Median	0.145
Variance	0.094345
StdDev	0.30716
Std Error	0.046306
Skewness	2.4037
Interquartile Range	0.26738

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.051	0.05525	0.0595	0.09688	0.145	0.3643	0.63	1.218	1.4

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Beryllium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.671	3.08	Yes

The test statistic 3.671 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Beryllium

1	1.4

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7068
Shapiro-Wilk 5% Critical Value	0.943

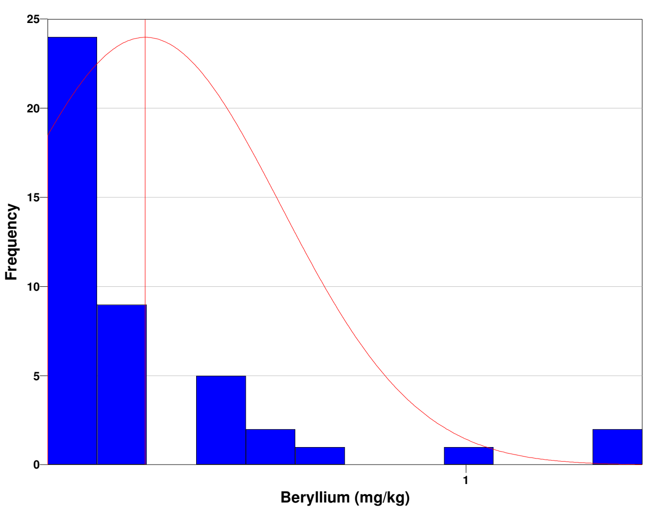
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

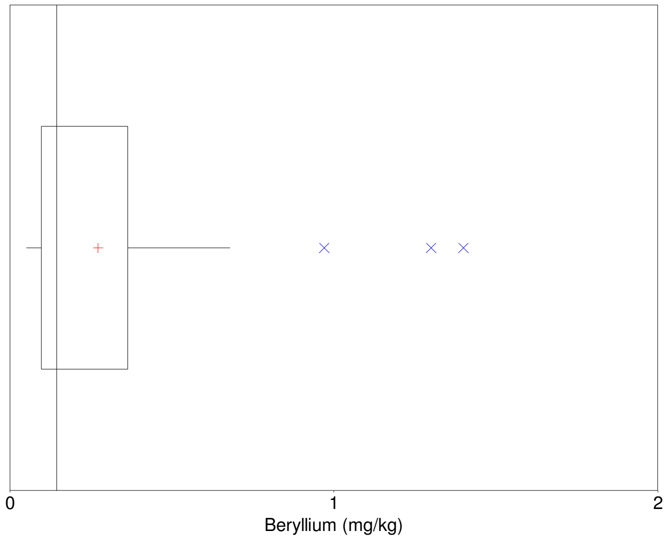
Data Plots for Beryllium
Graphical displays of the data are shown below.

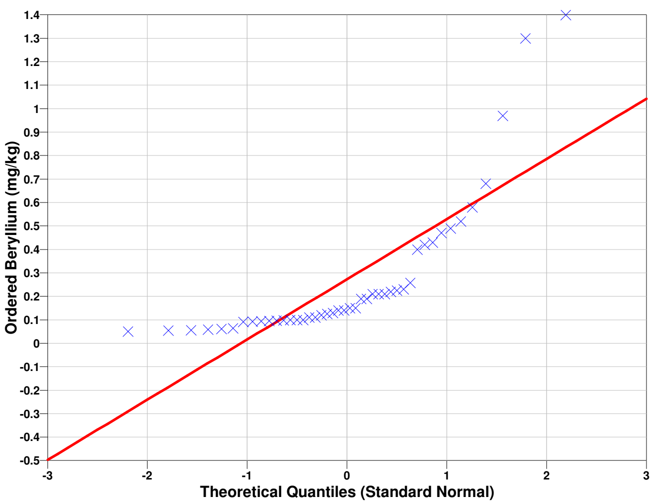
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Beryllium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6768
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.3503

95% Non-Parametric (Chebyshev) UCL	0.4743

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.4743) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (76000),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-577.2	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

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Software and documentation available at http://dqo.pnl.gov/vsp

* - The report contents may have been modified or reformatted by end-user of software.

Appendix C

VSP Reports of Calculated Minimum Sample Quantity
Report 24
Area of Concern – 3
Minimum Sample Quantity Calculation for Sediment using Human Health Benchmarks and Delta Method 2

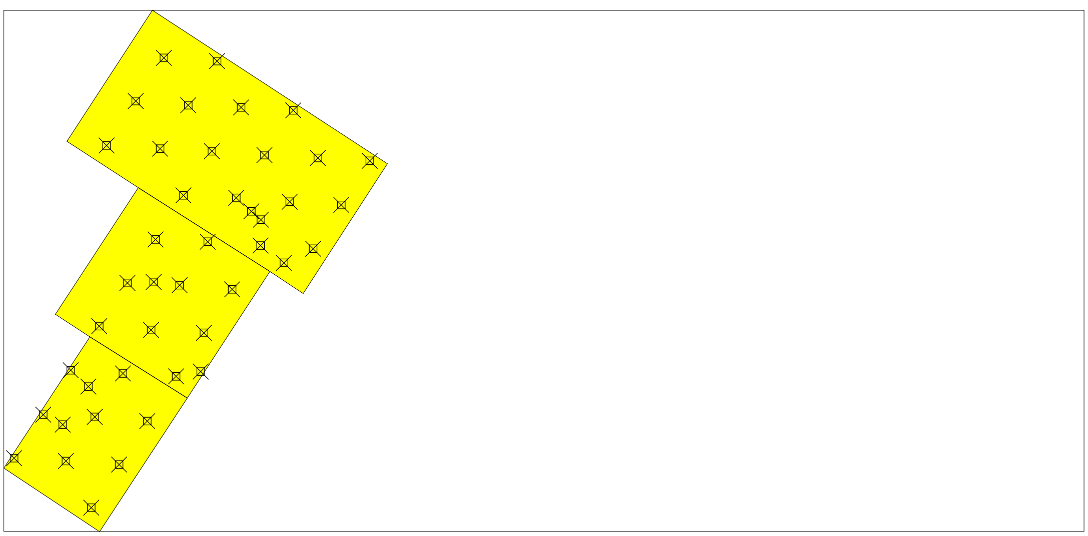
Random sampling locations for comparing a mean with a fixed threshold (parametric)

Summary
This report summarizes the sampling design, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design for Aluminum, the driving analyte (the analyte which required the largest number of samples). A figure that shows sampling locations in the field and a table that lists sampling location coordinates are also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean to a fixed threshold
Type of Sampling Design	Parametric
Sample Placement (Location) in the Field	Simple random sampling
Working (Null) Hypothesis	The mean value at the site exceeds the threshold
Formula for calculating number of sampling locations	Student's t-test
Calculated total number of samples	2
Number of samples on map [a]	43
Number of selected sample areas [b]	1
Specified sampling area [c]	602117.04 m^2
Total cost of sampling [d]	$2,000.00

[a] This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[d] Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.



Area: Area 1

X Coord	Y Coord	Label	Value	Type	Historical
679638.4660	3083412.5610	G-21SD		Manual	T
679715.3150	3083530.0190	G-22SD		Manual	T
679789.8310	3083644.9360	G-23SD		Manual	T
679780.1110	3083404.0250	G-24SD		Manual	T
679854.2250	3083519.8220	G-25SD		Manual	T
679931.3970	3083636.4060	G-26SD		Manual	T
679841.7740	3083280.2350	G-33SD		Manual	T
679917.7660	3083397.4160	G-34SD		Manual	T
679994.2070	3083513.4470	G-35SD		Manual	T
679982.2770	3083273.0650	G-42SD		Manual	T
680056.9810	3083387.3300	G-43SD		Manual	T
680132.6500	3083505.4560	G-44SD		Manual	T
680046.7830	3083146.9990	G-51SD		Manual	T
680123.4320	3083263.0010	G-52SD		Manual	T
680198.0580	3083379.8150	G-53SD		Manual	T
680185.4120	3083138.8470	G-54SD		Manual	T
680260.4210	3083254.8070	G-55SD		Manual	T
680335.9700	3083372.0200	G-56SD		Manual	T
680022.0080	3083237.4720	J-44SD		Manual	T
680047.0950	3083215.9420	J-45SD		Manual	T
680108.0130	3083101.3520	J-57SD		Manual	T
679619.1240	3082932.8980	G-30SD		Manual	T
679693.4050	3083047.5490	G-31SD		Manual	T
679768.2260	3083162.7270	G-32SD		Manual	T
679756.1090	3082922.9390	G-39SD		Manual	T
679832.1580	3083041.8710	G-40SD		Manual	T
679906.4210	3083156.7540	G-41SD		Manual	T
679822.0740	3082799.5750	G-48SD		Manual	T
679896.6120	3082915.6660	G-49SD		Manual	T
679971.2150	3083030.7920	G-50SD		Manual	T
679887.4330	3082812.9360	J-46SD		Manual	T
679763.3990	3083050.0550	J-56SD		Manual	T
679393.4380	3082582.9470	G-27SD		Manual	T
679470.2860	3082698.0210	G-28SD		Manual	T
679543.3140	3082816.1060	G-29SD		Manual	T
679530.9430	3082575.4480	G-36SD		Manual	T
679606.6840	3082692.3830	G-37SD		Manual	T
679681.4650	3082807.7990	G-38SD		Manual	T
679597.1880	3082450.9230	G-45SD		Manual	T
679671.3170	3082565.9250	G-46SD		Manual	T

679745.9820	3082681.3860	G-47SD		Manual	T
679521.7790	3082672.0220	J-54SD		Manual	T
679590.0920	3082773.1840	J-55SD		Manual	T

Primary Sampling Objective
The primary purpose of sampling at this site is to compare a mean value of a site with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the mean value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the mean value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative hypothesis, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach
A parametric random sampling approach was used to determine the number of samples and to specify sampling locations. A parametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that parametric assumptions are reasonable. These assumptions will be examined in post-sampling data analysis.

Both parametric and non-parametric approaches rely on assumptions about the population. However, non-parametric approaches typically require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than the number of samples required by non-parametric approaches.

Locating the sample points randomly provides data that are separated by many distances, whereas systematic samples are all equidistant apart. Therefore, random sampling provides more information about the spatial structure of the potential contamination than systematic sampling does. As with systematic sampling, random sampling also provides information regarding the mean value, but there is the possibility that areas of the site will not be represented with the same frequency as if uniform grid sampling were performed.

Number of Total Samples: Calculation Equation and Inputs
The equation used to calculate the number of samples is based on a Student's t-test. For this site, the null hypothesis is rejected in favor of the alternative hypothesis if the sample mean is sufficiently smaller than the threshold. The number of samples to collect is calculated so that 1) there will be a high probability ($1-\beta$) of rejecting the null hypothesis if the alternative hypothesis is true and 2) a low probability (α) of rejecting the null hypothesis if the null hypothesis is true.

The formula used to calculate the number of samples is:

$$n = \frac{S^2}{\Delta^2}\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2 + 0.5Z_{1-\alpha}^2$$

where
n is the number of samples,
S is the estimated standard deviation of the measured values including analytical error,
Δ is the width of the gray region,
α is the acceptable probability of incorrectly concluding the site mean is less than the threshold,
β is the acceptable probability of incorrectly concluding the site mean exceeds the threshold,
$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is $1-\alpha$,
$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is $1-\beta$.

The values of these inputs that result in the calculated number of sampling locations are:

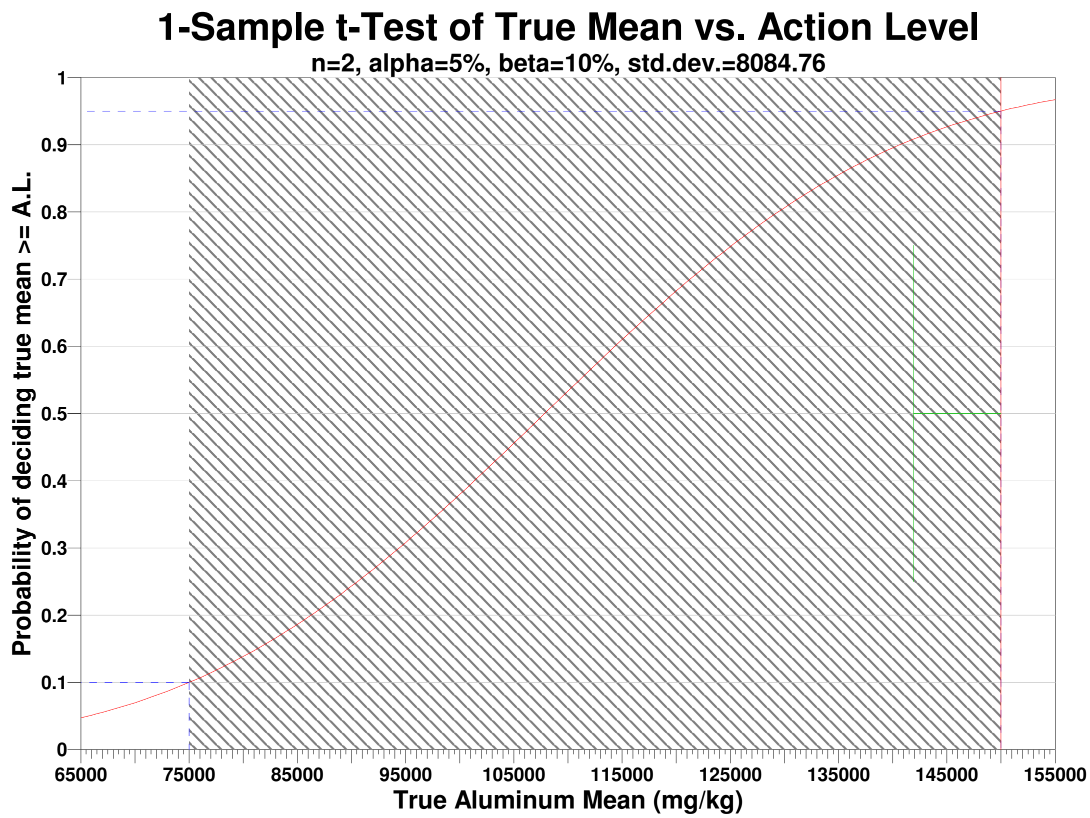
Analyte	**n**	**Parameter**					
		S	**Δ**	**α**	**β**	$Z_{1-\alpha}$ [a]	$Z_{1-\beta}$ [b]
New Location	2	0.1 mg/kg	10 mg/kg	0.05	0.1	1.64485	1.28155
1_2_4-Trimethylbenzene	2	0.000903411 mg/kg	18500 mg/kg	0.05	0.1	1.64485	1.28155
Acetone	2	0.107526 mg/kg	330000 mg/kg	0.05	0.1	1.64485	1.28155
Aluminum	2	8084.76 mg/kg	75000 mg/kg	0.05	0.1	1.64485	1.28155

Arsenic	2	2.98866 mg/kg	55 mg/kg	0.05	0.1	1.64485	1.28155
Barium	2	302.768 mg/kg	11500 mg/kg	0.05	0.1	1.64485	1.28155
bis(2-Ethylhexyl)phthalate	2	0.132826 mg/kg	120 mg/kg	0.05	0.1	1.64485	1.28155
Cadmium	2	0.133983 mg/kg	550 mg/kg	0.05	0.1	1.64485	1.28155
Carbon disulfide	2	0.00443094 mg/kg	36500 mg/kg	0.05	0.1	1.64485	1.28155
Chromium	2	7.12413 mg/kg	18000 mg/kg	0.05	0.1	1.64485	1.28155
Cobalt	2	2.15433 mg/kg	16000 mg/kg	0.05	0.1	1.64485	1.28155
Copper	2	10.8021 mg/kg	10500 mg/kg	0.05	0.1	1.64485	1.28155
Hexane	2	0.00153868 mg/kg	22000 mg/kg	0.05	0.1	1.64485	1.28155
Lead	2	7.70564 mg/kg	250 mg/kg	0.05	0.1	1.64485	1.28155
Manganese	2	146.86 mg/kg	7000 mg/kg	0.05	0.1	1.64485	1.28155
Mercury	2	0.0182741 mg/kg	17 mg/kg	0.05	0.1	1.64485	1.28155
Methyl ethyl ketone	2	0.0207644 mg/kg	220000 mg/kg	0.05	0.1	1.64485	1.28155
Methylene chloride	2	0.00286889 mg/kg	3650 mg/kg	0.05	0.1	1.64485	1.28155
Nickel	2	4.87105 mg/kg	700 mg/kg	0.05	0.1	1.64485	1.28155
Selenium	2	0.384345 mg/kg	1350 mg/kg	0.05	0.1	1.64485	1.28155
Silver	2	0.246449 mg/kg	175 mg/kg	0.05	0.1	1.64485	1.28155
Toluene	2	0.00557446 mg/kg	29500 mg/kg	0.05	0.1	1.64485	1.28155
Vanadium	2	12.2786 mg/kg	165 mg/kg	0.05	0.1	1.64485	1.28155
Zinc	2	227.274 mg/kg	38000 mg/kg	0.05	0.1	1.64485	1.28155
Beryllium	2	0.307158 mg/kg	13.5 mg/kg	0.05	0.1	1.64485	1.28155

[a] This value is automatically calculated by VSP based upon the user defined value of α.
[b] This value is automatically calculated by VSP based upon the user defined value of β.

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000) for Aluminum, the driving analyte. It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true mean values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at 1-α on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at 1-α. If any of the inputs change, the number of samples that result in the correct curve changes.



Statistical Assumptions

The assumptions associated with the formulas for computing the number of samples are:

1. the sample mean is normally distributed (this happens if the data are roughly symmetric or the sample size is more than 30; for extremely skewed data sets, additional samples may be required for the sample mean to be normally distributed),
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected randomly.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the sample locations were selected using a random process.

Sensitivity Analysis

The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that μ > action level and alpha (%), probability of mistakenly concluding that μ < action level. The following table shows the results of this analysis.

Number of Samples							
AL=0		α=5		α=10		α=15	
		s=0.2	s=0.1	s=0.2	s=0.1	s=0.2	s=0.1
LBGR=90	β=5	2	2	1	1	1	1
	β=10	2	2	1	1	1	1
	β=15	2	2	1	1	1	1
LBGR=80	β=5	2	2	1	1	1	1
	β=10	2	2	1	1	1	1
	β=15	2	2	1	1	1	1
LBGR=70	β=5	2	2	1	1	1	1

	β=10	2	2	1	1	1	1
	β=15	2	2	1	1	1	1

s = Standard Deviation
LBGR = Lower Bound of Gray Region (% of Action Level)
β = Beta (%), Probability of mistakenly concluding that μ > action level
α = Alpha (%), Probability of mistakenly concluding that μ < action level
AL = Action Level (Threshold)

Cost of Sampling
The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that are based on the number of samples collected and measured. Based on the numbers of samples determined above, the estimated total cost of sampling and analysis at this site is $2,000.00, which averages out to a per sample cost of $1,000.00. The following table summarizes the inputs and resulting cost estimates.

COST INFORMATION			
Cost Details	**Per Analysis**	**Per Sample**	**2 Samples**
Field collection costs		$100.00	$200.00
Analytical costs	$400.00	$400.00	$800.00
Sum of Field & Analytical costs		**$500.00**	**$1,000.00**
Fixed planning and validation costs			$1,000.00
Total cost			**$2,000.00**

Data Analysis for 1_2_4-Trimethylbenzene
The following data points were entered by the user for analysis.

1_2_4-Trimethylbenzene (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00055	0.0006	0.0006	0.0006	0.0006	0.0006	0.000625	0.00065	0.00065	0.00065
10	0.00065	0.00065	0.00065	0.00065	0.00065	0.00065	0.00065	0.00065	0.00065	0.00065
20	0.0007	0.0007	0.0007	0.0007	0.0007	0.00075	0.00075	0.0008	0.00085	0.00085
30	0.0009	0.0009	0.00095	0.001	0.00105	0.00115	0.00125	0.00125	0.0014	0.0015
40	0.0018	0.00275	0.0045	0.0049						

SUMMARY STATISTICS for 1_2_4-Trimethylbenzene	
n	44
Min	0.00055
Max	0.0049
Range	0.00435
Mean	0.0010324
Median	0.0007
Variance	8.1615e-007
StdDev	0.00090341
Std Error	0.00013619
Skewness	3.4257

Interquartile Range				0.0003375				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00055	0.0006	0.0006	0.00065	0.0007	0.0009875	0.00165	0.004063	0.0049

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for 1_2_4-Trimethylbenzene			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.281	3.08	Yes

The test statistic 4.281 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for 1_2_4-Trimethylbenzene	
1	0.0049

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5241
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

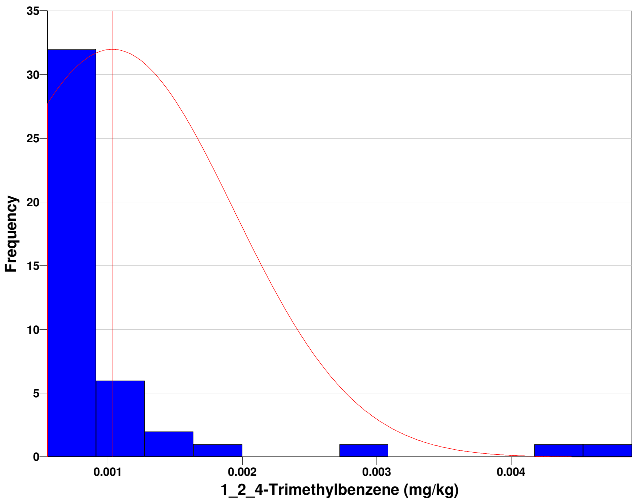
Data Plots for 1_2_4-Trimethylbenzene
Graphical displays of the data are shown below.

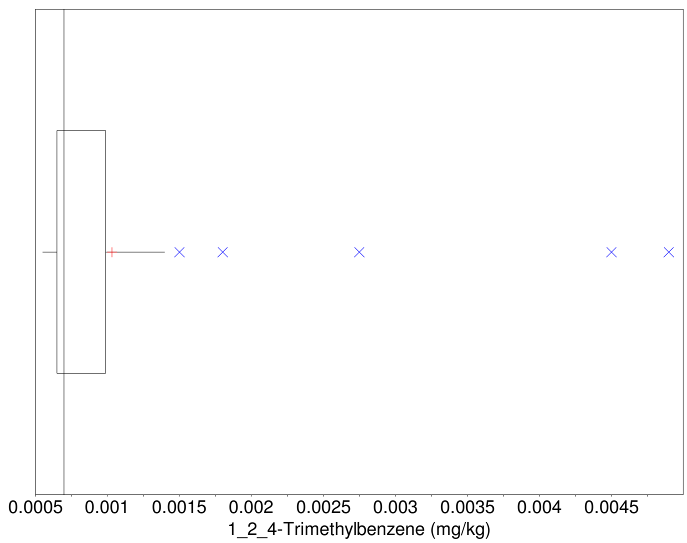
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

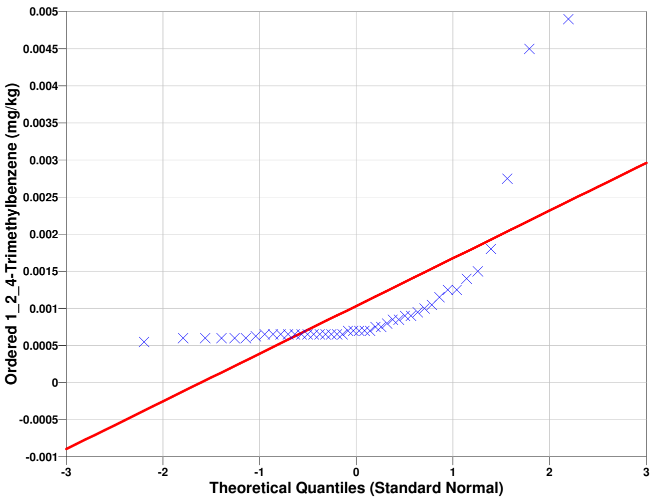
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends

to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for 1_2_4-Trimethylbenzene
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5053
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.001261
95% Non-Parametric (Chebyshev) UCL	0.001626

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.001626) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-2.7167e+008	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Acetone
The following data points were entered by the user for analysis.

Acetone (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0036	0.0037	0.00385	0.004	0.004	0.0041	0.0041	0.0042	0.0042	0.0042
10	0.00425	0.0043	0.0043	0.00455	0.00465	0.0048	0.0065	0.0082	0.0092	0.0111

20	0.0112	0.0135	0.0173	0.0189	0.0196	0.0265	0.0336	0.0436	0.048	0.0492
30	0.0499	0.0562	0.0659	0.0698	0.0722	0.088	0.107	0.123	0.128	0.15
40	0.151	0.174	0.18	0.668						

SUMMARY STATISTICS for Acetone								
n	44							
Min	0.0036							
Max	0.668							
Range	0.6644							
Mean	0.05605							
Median	0.0154							
Variance	0.011562							
StdDev	0.10753							
Std Error	0.01621							
Skewness	4.5508							
Interquartile Range	0.064562							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0036	0.003738	0.004	0.004263	0.0154	0.06882	0.1505	0.1785	0.668

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Acetone			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.691	3.08	Yes

The test statistic 5.691 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Acetone	
1	0.668

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)

Shapiro-Wilk Test Statistic	0.7465
Shapiro-Wilk 5% Critical Value	0.943

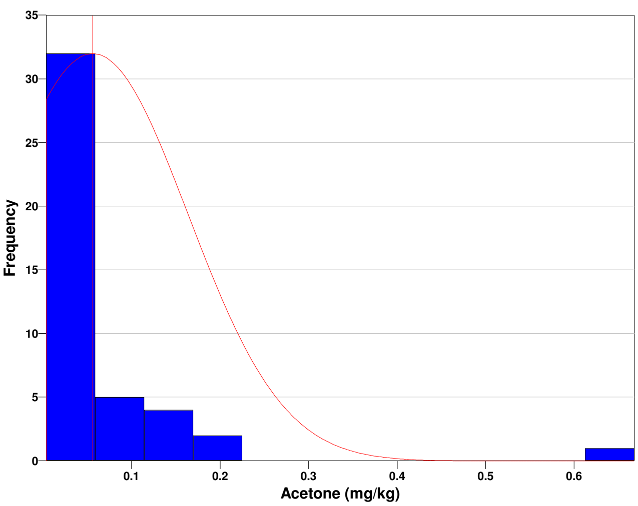
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

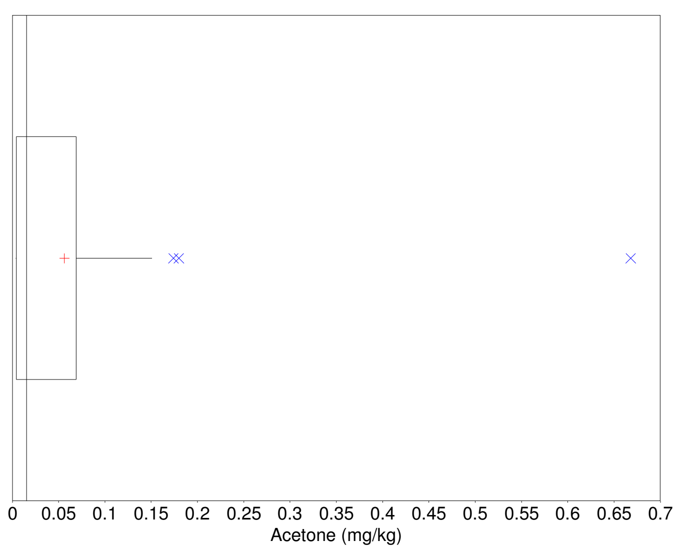
Data Plots for Acetone
Graphical displays of the data are shown below.

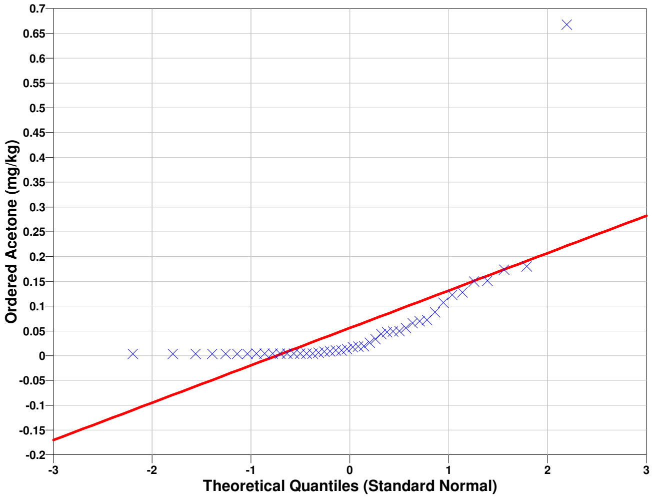
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Acetone
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5093
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.0833
95% Non-Parametric (Chebyshev) UCL	0.1267

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.1267) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-4.0715e+007	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Aluminum
The following data points were entered by the user for analysis.

Aluminum (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	953	971	1080	1180	1210	1490	1670	1790	1900	1960
10	2010	2060	2060	2180	2220	2240	2330	2390	2600	2750
20	2860	2860	2870	3810	4290	4560	4660	5000	5490	5590
30	5620	6170	6530	1.03e+004	1.04e+004	1.09e+004	1.17e+004	1.23e+004	1.34e+004	1.45e+004
40	1.89e+004	2.31e+004	3.47e+004	3.59e+004						

SUMMARY STATISTICS for Aluminum								
n	44							
Min	953							
Max	35900							
Range	34947							
Mean	6669.4							
Median	2865							
Variance	6.5361e+007							
StdDev	8084.6							
Std Error	1218.8							
Skewness	2.3968							
Interquartile Range	7335							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
953	998.3	1195	2023	2865	9358	1.67e+004	3.18e+004	3.59e+004

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Aluminum			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.616	3.08	Yes

The test statistic 3.616 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Aluminum	
1	35900

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7062
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

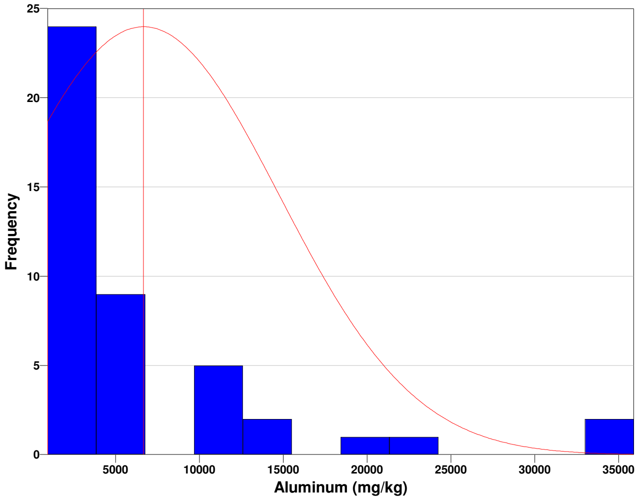
Data Plots for Aluminum
Graphical displays of the data are shown below.

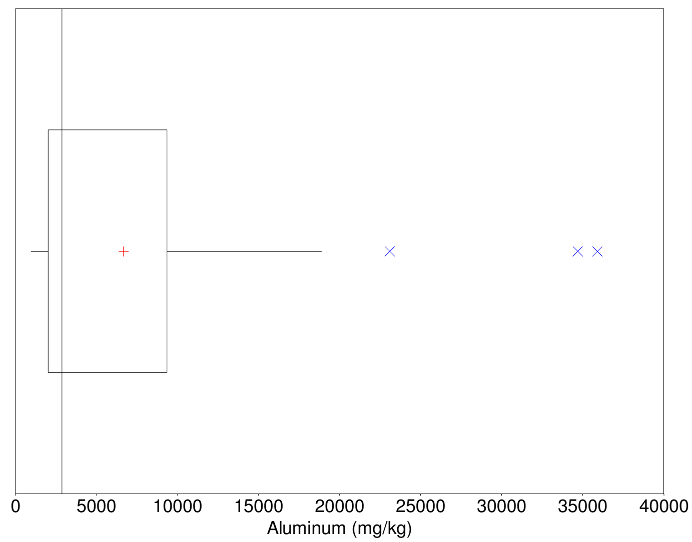
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

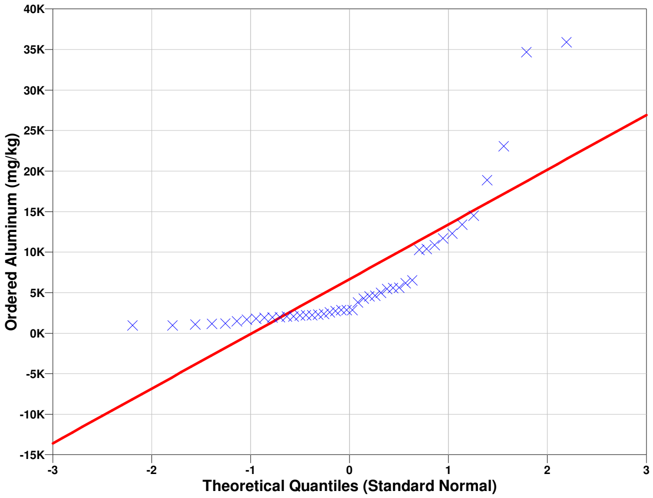
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the

Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Aluminum

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6759
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	8718
95% Non-Parametric (Chebyshev) UCL	1.198e+004

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (1.198e+004) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-117.6	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Arsenic
The following data points were entered by the user for analysis.

Arsenic (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.31	0.33	0.43	0.45	0.455	0.625	0.67	0.74	0.75	0.75
10	0.79	0.86	0.86	1.1	1.3	1.3	1.4	1.4	1.4	1.5
20	1.5	1.5	1.6	1.6	1.6	1.7	1.7	2.13	2.2	2.3
30	2.4	2.4	2.6	2.8	2.8	3.3	4.7	4.8	5	6.3
40	6.3	6.5	8.9	17.3						

SUMMARY STATISTICS for Arsenic	
n	44

Min	0.31							
Max	17.3							
Range	16.99							
Mean	2.5307							
Median	1.55							
Variance	8.9321							
StdDev	2.9887							
Std Error	0.45056							
Skewness	3.2631							
Interquartile Range	1.9425							
Percentiles								
1%	5%	10%	25%	50%	75%	90%	95%	99%
0.31	0.355	0.4525	0.8075	1.55	2.75	6.3	8.3	17.3

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Arsenic			
k	Test Statistic R_k	5% Critical Value C_k	Significant?
1	4.942	3.08	Yes

The test statistic 4.942 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Arsenic	
1	17.3

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.794
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

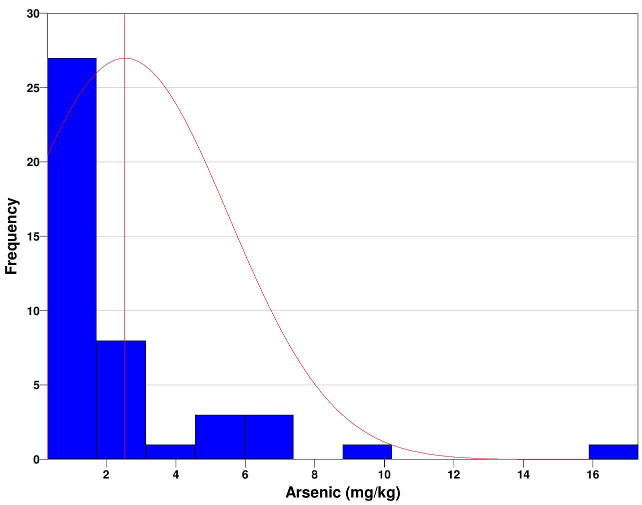
Data Plots for Arsenic

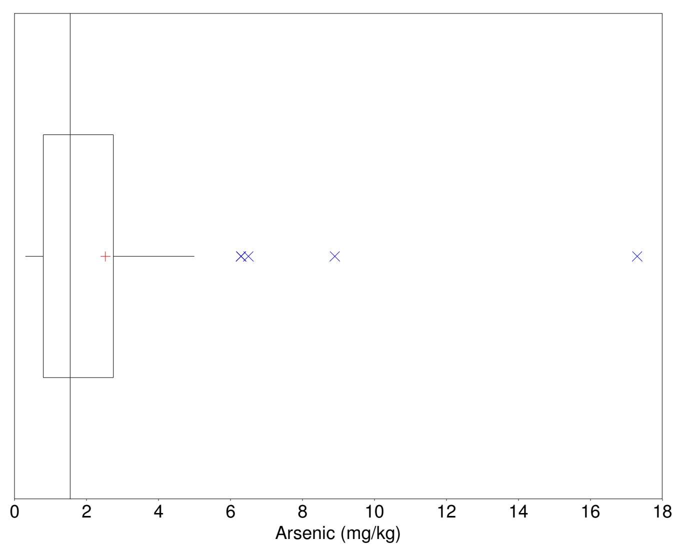
Graphical displays of the data are shown below.

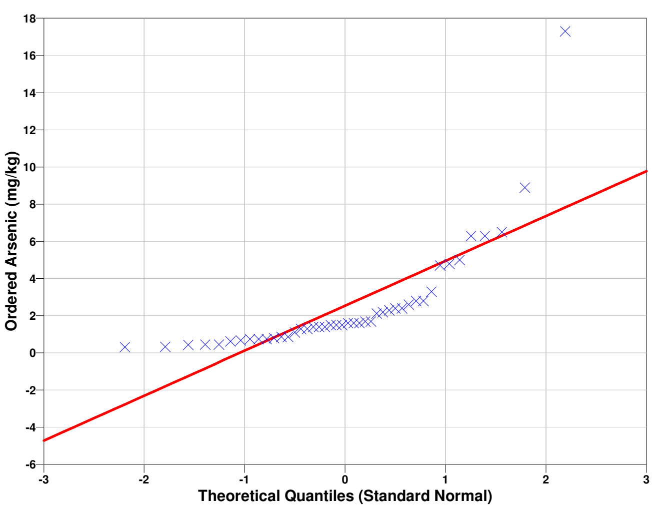
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Arsenic
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6543
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	3.288
95% Non-Parametric (Chebyshev) UCL	4.495

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (4.495) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-238.53	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**

44	27	Reject

Data Analysis for Barium
The following data points were entered by the user for analysis.

Barium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	7.8	10.4	22.8	22.8	23.1	24.3	25.8	29.2	34.4	36.8
10	45.1	47.4	47.8	48.4	62.5	63.9	66.2	67.1	68.4	71.6
20	72.4	78.5	80.9	89	90.5	94	95.2	118	133	134
30	174	176	209	211	277	308	310	332	343	404
40	471	514	1100	1700						

SUMMARY STATISTICS for Barium								
n	44							
Min	7.8							
Max	1700							
Range	1692.2							
Mean	189.55							
Median	79.7							
Variance	92020							
StdDev	303.35							
Std Error	45.731							
Skewness	3.666							
Interquartile Range	164.82							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
7.8	13.5	22.95	45.67	79.7	210.5	437.5	953.5	1700

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Barium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.979	3.08	Yes

The test statistic 4.979 exceeded the corresponding critical value, therefore that test is significant and we conclude that the

most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Barium	
1	1700

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6749
Shapiro-Wilk 5% Critical Value	0.943

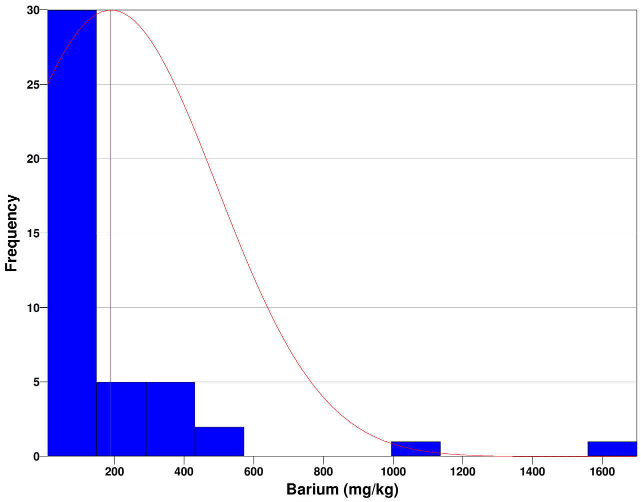
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

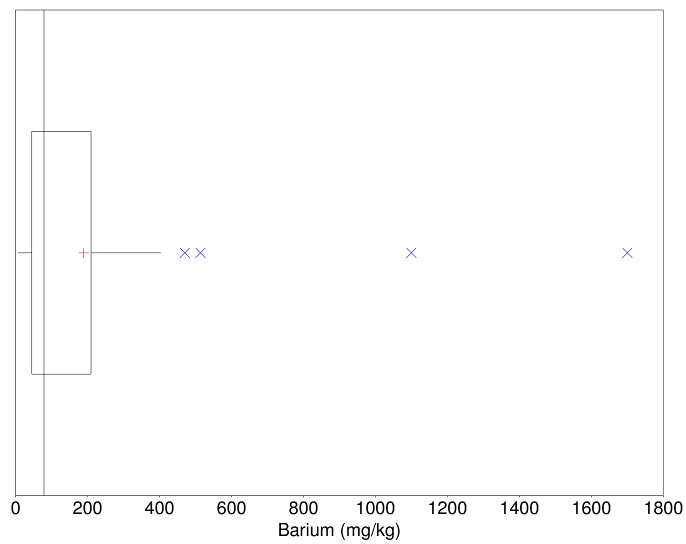
Data Plots for Barium
Graphical displays of the data are shown below.

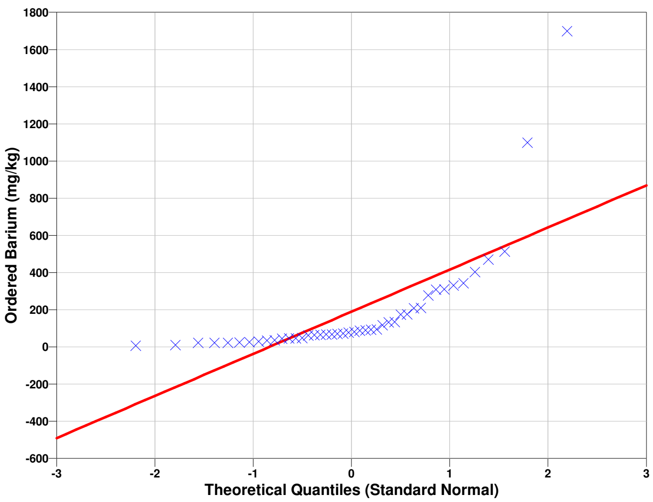
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Barium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5638
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	266.4

95% Non-Parametric (Chebyshev) UCL	388.9

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (388.9) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-498.79	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for bis(2-Ethylhexyl)phthalate
The following data points were entered by the user for analysis.

bis(2-Ethylhexyl)phthalate (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.046	0.0465	0.047	0.0479	0.048	0.0483	0.0485	0.0485	0.0485	0.049
10	0.0495	0.0495	0.0498	0.05	0.05	0.05	0.05	0.0525	0.055	0.055
20	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.06	0.06	0.065
30	0.065	0.065	0.065	0.075	0.085	0.095	0.1	0.136	0.153	0.215
40	0.342	0.408	0.444	0.729						

SUMMARY STATISTICS for bis(2-Ethylhexyl)phthalate	
n	44
Min	0.046
Max	0.729

Range				0.683				
Mean				0.1031				
Median				0.055				
Variance				0.017642				
StdDev				0.13282				
Std Error				0.020024				
Skewness				3.3692				
Interquartile Range				0.023				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.046	0.04663	0.04795	0.0495	0.055	0.0725	0.2785	0.435	0.729

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for bis(2-Ethylhexyl)phthalate			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.712	3.08	Yes

The test statistic 4.712 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for bis(2-Ethylhexyl)phthalate	
1	0.729

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.4909
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

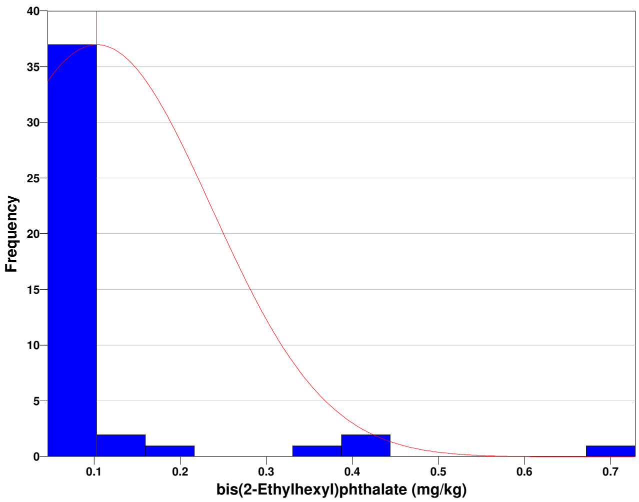
Data Plots for bis(2-Ethylhexyl)phthalate
Graphical displays of the data are shown below.

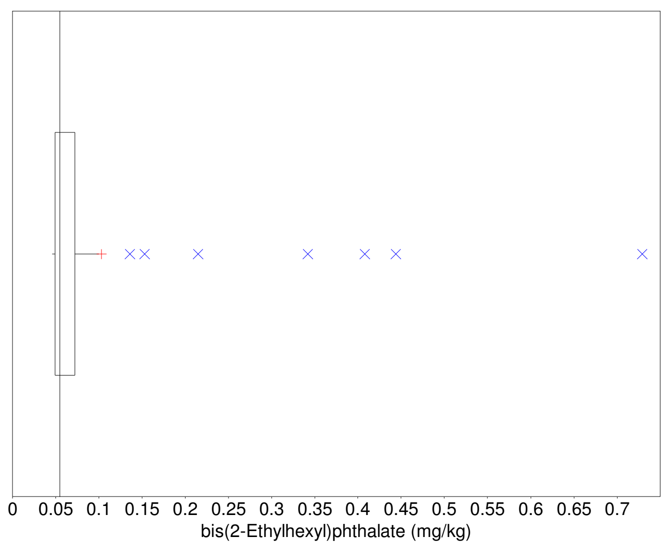
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

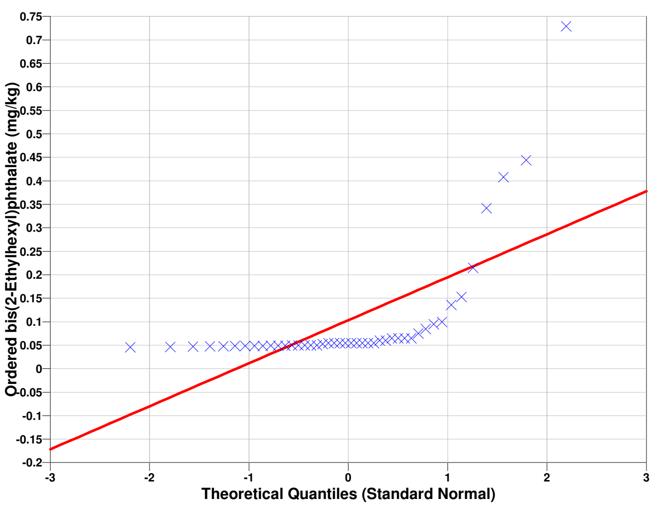
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for bis(2-Ethylhexyl)phthalate
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.4804
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.1368
95% Non-Parametric (Chebyshev) UCL	0.1904

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.1904) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-11980	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Cadmium
The following data points were entered by the user for analysis.

Cadmium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0475	0.048	0.05	0.05	0.05	0.05	0.052	0.055	0.055	0.055
10	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.0575
20	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.065	0.065	0.065
30	0.07	0.09	0.115	0.115	0.12	0.2	0.21	0.235	0.25	0.32
40	0.33	0.41	0.48	0.67						

SUMMARY STATISTICS for Cadmium	
n	44
Min	0.0475
Max	0.67
Range	0.6225
Mean	0.12034
Median	0.06
Variance	0.017952
StdDev	0.13398
Std Error	0.020199
Skewness	2.5395
Interquartile Range	0.06

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0475	0.0485	0.05	0.055	0.06	0.115	0.325	0.4625	0.67

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Cadmium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.102	3.08	Yes

The test statistic 4.102 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Cadmium

1	0.67

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6044
Shapiro-Wilk 5% Critical Value	0.943

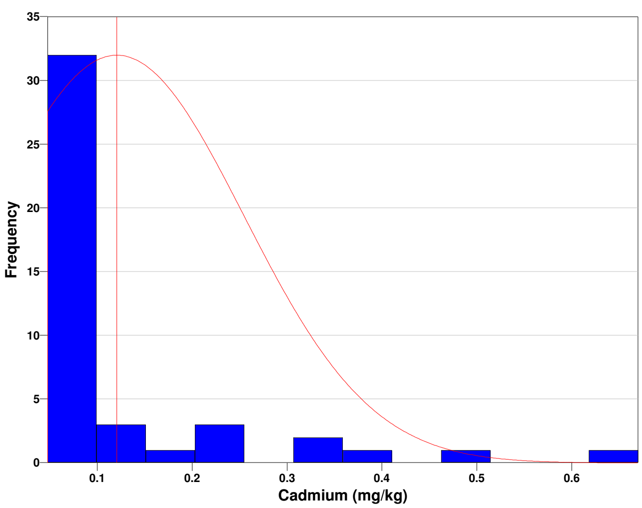
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

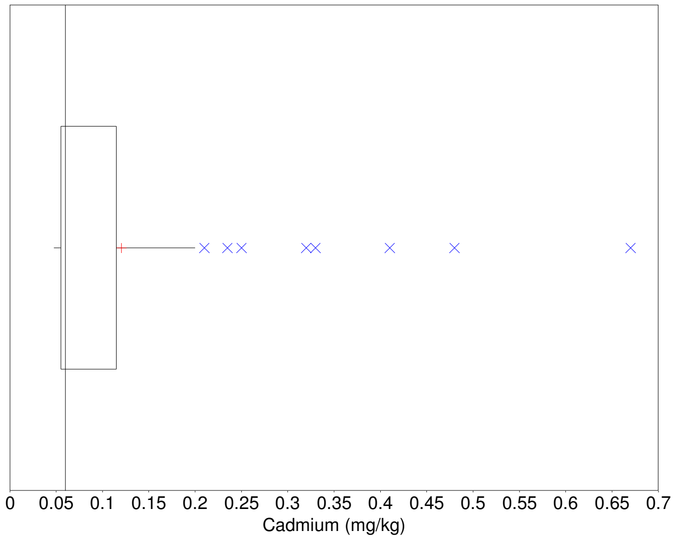
Data Plots for Cadmium
Graphical displays of the data are shown below.

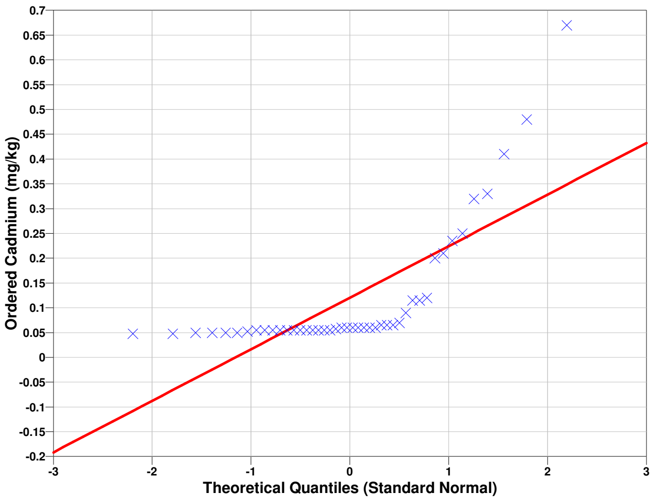
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Cadmium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5927
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.1543

95% Non-Parametric (Chebyshev) UCL	0.2084

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.2084) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-54453	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Carbon disulfide
The following data points were entered by the user for analysis.

Carbon disulfide (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00065	0.00065	0.00065	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007
10	0.0007	0.000725	0.000725	0.000725	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075
20	0.00075	0.00075	0.00075	0.0008	0.0008	0.0008	0.0008	0.0008	0.00085	0.0009
30	0.00105	0.0011	0.00115	0.00145	0.0029	0.0032	0.0041	0.0042	0.0048	0.0068
40	0.009	0.0112	0.0139	0.0241						

SUMMARY STATISTICS for Carbon disulfide	
n	44
Min	0.00065
Max	0.0241

Range				0.02345				
Mean				0.0025267				
Median				0.00075				
Variance				1.9633e-005				
StdDev				0.0044309				
Std Error				0.00066799				
Skewness				3.4594				
Interquartile Range				0.00066875				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00065	0.00065	0.0007	0.0007062	0.00075	0.001375	0.0079	0.01322	0.0241

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Carbon disulfide			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.869	3.08	Yes

The test statistic 4.869 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Carbon disulfide	
1	0.0241

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5283
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

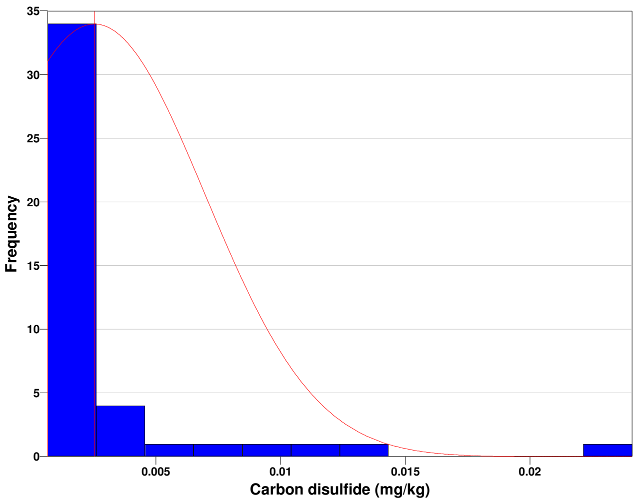
Data Plots for Carbon disulfide
Graphical displays of the data are shown below.

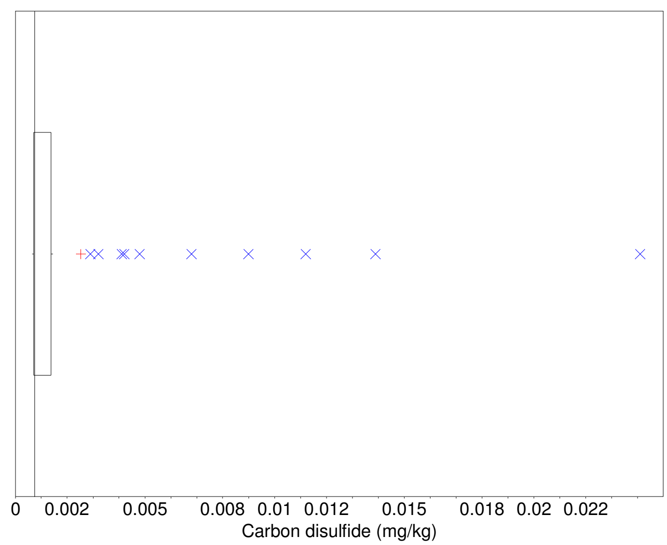
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

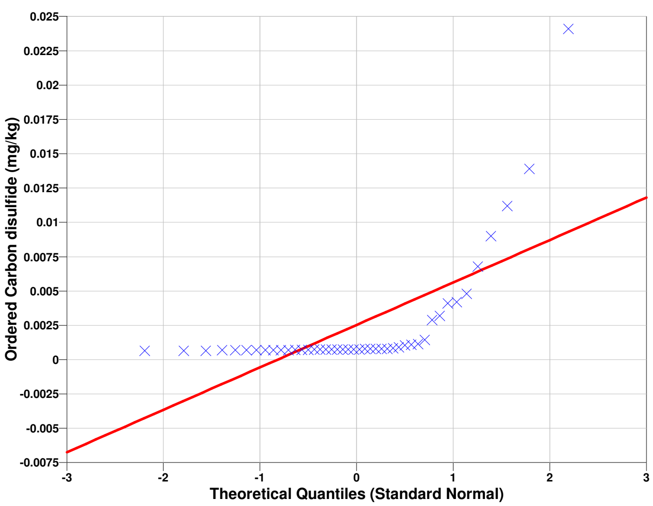
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Carbon disulfide
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.4933
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.00365
95% Non-Parametric (Chebyshev) UCL	0.005438

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.005438) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.0928e+008	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Chromium
The following data points were entered by the user for analysis.

Chromium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1.1	1.2	1.2	1.3	1.35	1.6	1.9	2	2	2.1
10	2.2	2.3	2.35	2.4	2.4	2.4	2.4	2.5	2.7	2.9
20	2.9	3.3	3.3	3.3	3.5	4.2	4.2	4.45	4.5	4.7
30	5.7	6.3	7.55	7.6	9.2	9.4	11.8	13.6	14.6	14.9
40	17.4	23.8	28.9	29.9						

SUMMARY STATISTICS for Chromium	
n	44
Min	1.1
Max	29.9
Range	28.8
Mean	6.3477
Median	3.3
Variance	50.753
StdDev	7.1241
Std Error	1.074
Skewness	2.0955
Interquartile Range	5.3625

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
1.1	1.2	1.325	2.225	3.3	7.587	16.15	27.63	29.9

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Chromium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.306	3.08	Yes

The test statistic 3.306 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Chromium

1	29.9

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7122
Shapiro-Wilk 5% Critical Value	0.943

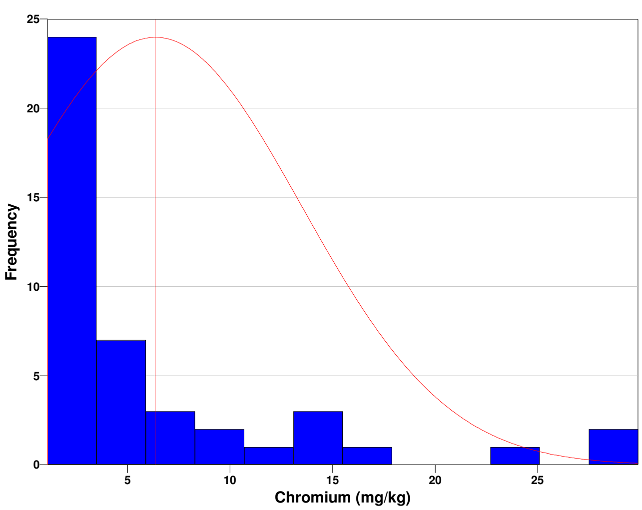
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

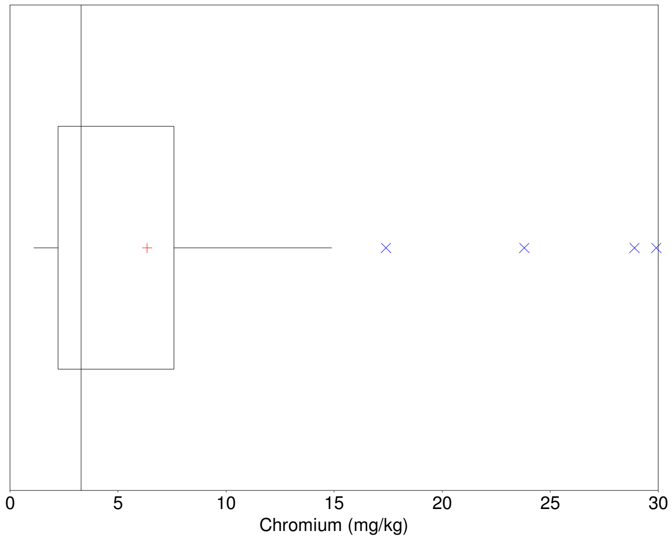
Data Plots for Chromium
Graphical displays of the data are shown below.

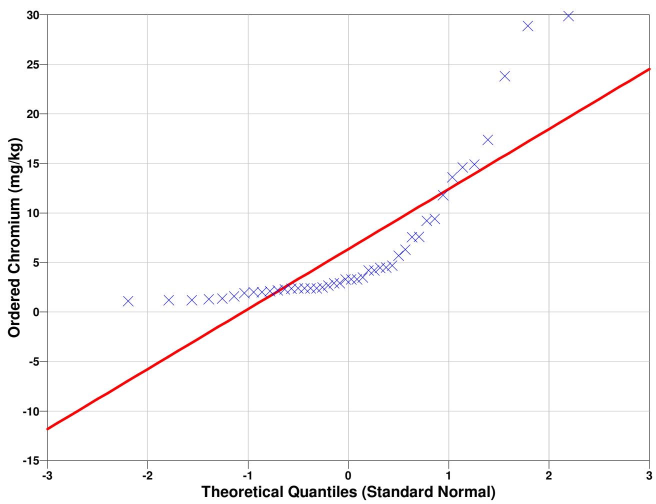
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Chromium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6948
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	8.153

95% Non-Parametric (Chebyshev) UCL	11.03

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (11.03) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-33514	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Cobalt
The following data points were entered by the user for analysis.

Cobalt (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.183	0.2	0.22	0.27	0.32	0.34	0.42	0.46	0.52	0.55
10	0.56	0.56	0.57	0.62	0.64	0.67	0.67	0.74	0.79	0.81
20	0.91	0.93	0.95	1.03	1.1	1.15	1.3	1.4	1.4	1.4
30	1.4	1.6	1.72	2.5	2.8	2.8	2.9	3.1	3.2	4.1
40	4.3	5.8	9	10.4						

SUMMARY STATISTICS for Cobalt	
n	44
Min	0.183
Max	10.4

Range				10.217				
Mean				1.7569				
Median				0.94				
Variance				4.6409				
StdDev				2.1543				
Std Error				0.32477				
Skewness				2.646				
Interquartile Range				1.745				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.183	0.205	0.295	0.56	0.94	2.305	4.2	8.2	10.4

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Cobalt			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.012	3.08	Yes

The test statistic 4.012 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Cobalt	
1	10.4

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7178
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

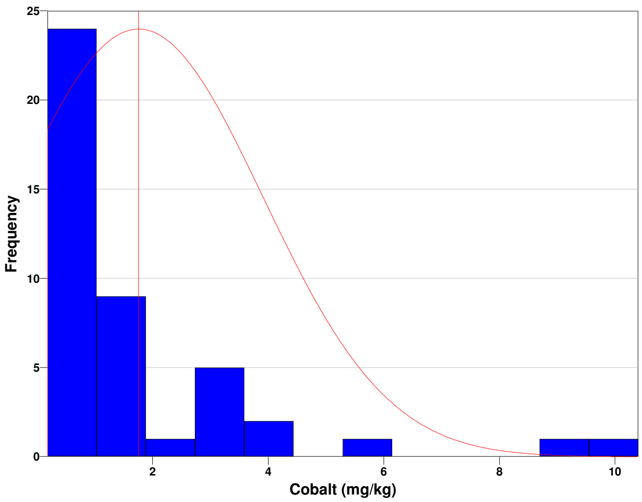
Data Plots for Cobalt
Graphical displays of the data are shown below.

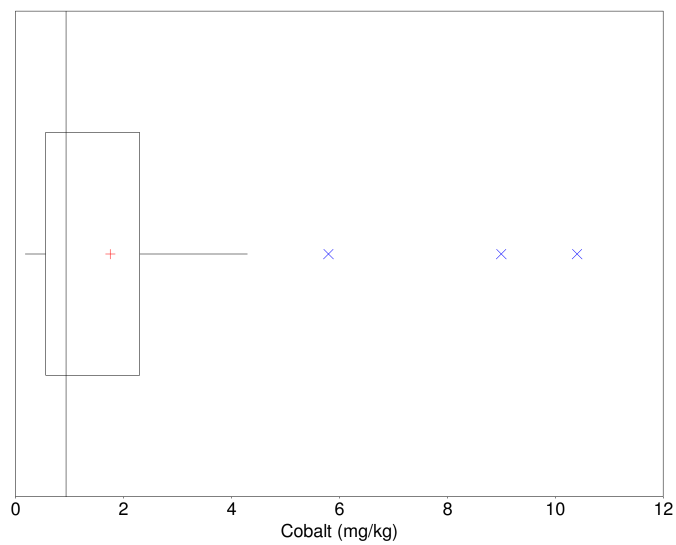
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

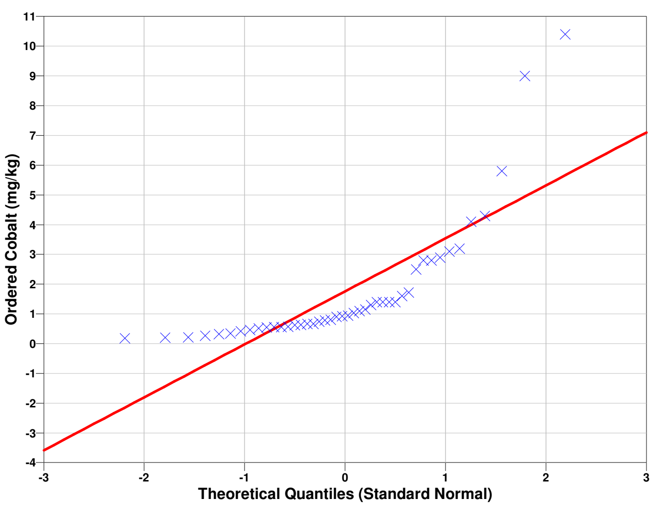
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Cobalt
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6692
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	2.303
95% Non-Parametric (Chebyshev) UCL	3.173

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (3.173) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-98526	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Copper
The following data points were entered by the user for analysis.

Copper (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1.1	1.1	1.1	1.1	1.1	1.3	1.5	1.5	1.8	1.9
10	1.9	2.1	2.1	2.2	2.5	2.5	2.5	2.6	2.8	2.8
20	2.9	2.95	3.25	3.3	3.3	3.5	3.6	4.1	4.2	4.4
30	4.6	5.3	7.1	7.7	8	12.1	15.9	19.3	20.7	21.2
40	23	24.9	32.2	57.1						

SUMMARY STATISTICS for Copper								
n	44							
Min	1.1							
Max	57.1							
Range	56							
Mean	7.5477							
Median	3.1							
Variance	116.7							
StdDev	10.803							
Std Error	1.6286							
Skewness	2.8641							
Interquartile Range	5.6							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
1.1	1.1	1.1	1.95	3.1	7.55	22.1	30.38	57.1

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Copper			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.587	3.08	Yes

The test statistic 4.587 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Copper

1	57.1

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6764
Shapiro-Wilk 5% Critical Value	0.943

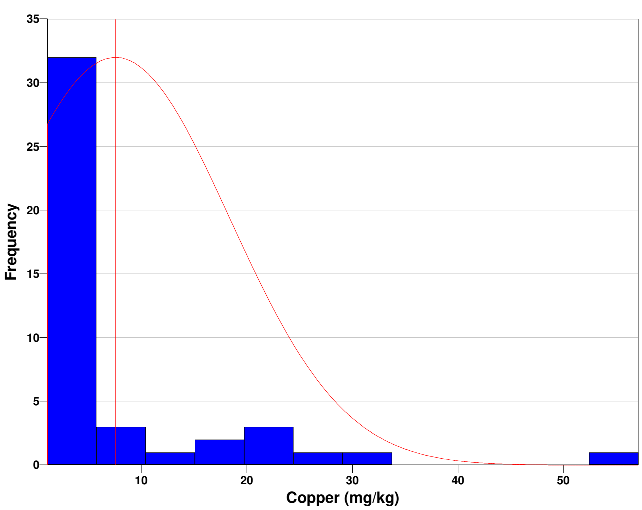
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

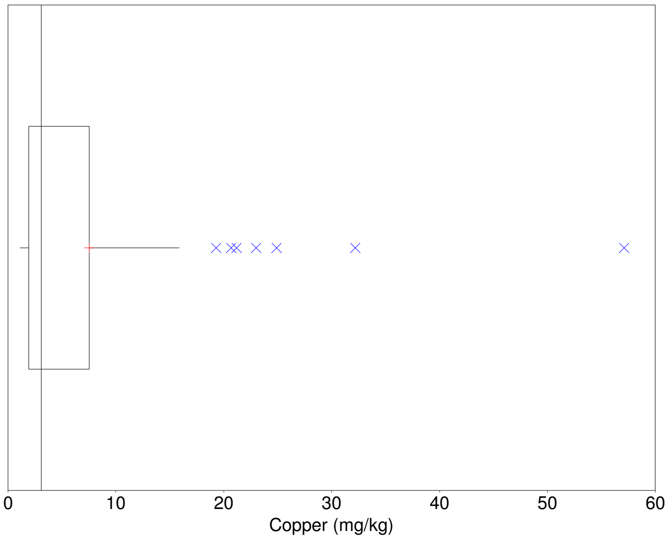
Data Plots for Copper
Graphical displays of the data are shown below.

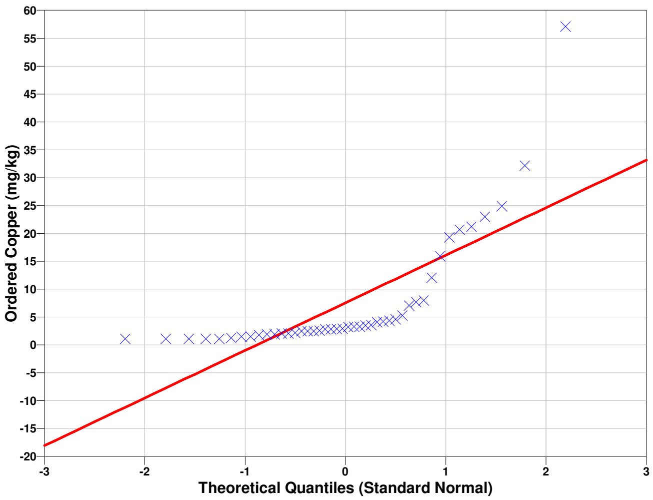
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Copper
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.62
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	10.29

95% Non-Parametric (Chebyshev) UCL	14.65

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (14.65) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-12890	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Hexane
The following data points were entered by the user for analysis.

Hexane (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00055	0.00055	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006
10	0.0006	0.0006	0.0006	0.0006	0.000625	0.000625	0.00065	0.00065	0.00065	0.00065
20	0.0007	0.0007	0.0007	0.000725	0.00075	0.0008	0.0008	0.0009	0.00095	0.001
30	0.0011	0.0012	0.0012	0.0013	0.0019	0.0022	0.0022	0.0023	0.0023	0.0026
40	0.0026	0.0033	0.0063	0.0086						

SUMMARY STATISTICS for Hexane	
n	44
Min	0.00055
Max	0.0086

Range				0.00805				
Mean				0.0013472				
Median				0.0007				
Variance				2.3675e-006				
StdDev				0.0015387				
Std Error				0.00023196				
Skewness				3.3948				
Interquartile Range				0.000675				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00055	0.0005625	0.0006	0.0006	0.0007	0.001275	0.0026	0.00555	0.0086

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Hexane			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.714	3.08	Yes

The test statistic 4.714 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Hexane	
1	0.0086

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6129
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

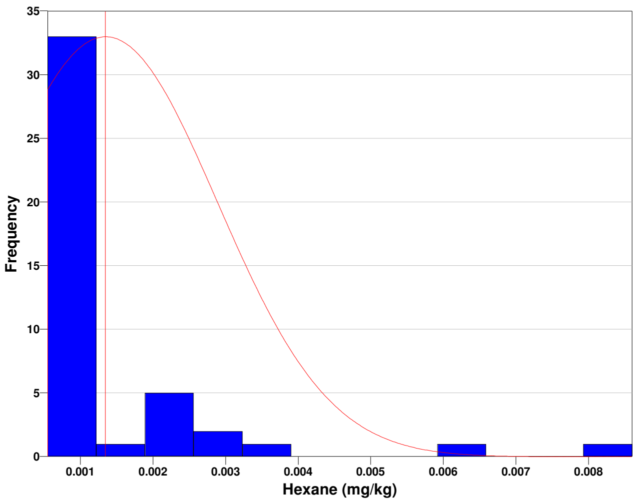
Data Plots for Hexane
Graphical displays of the data are shown below.

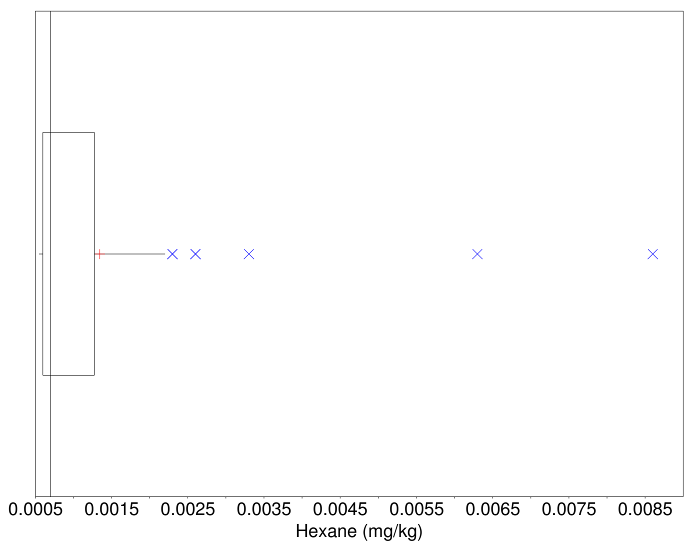
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

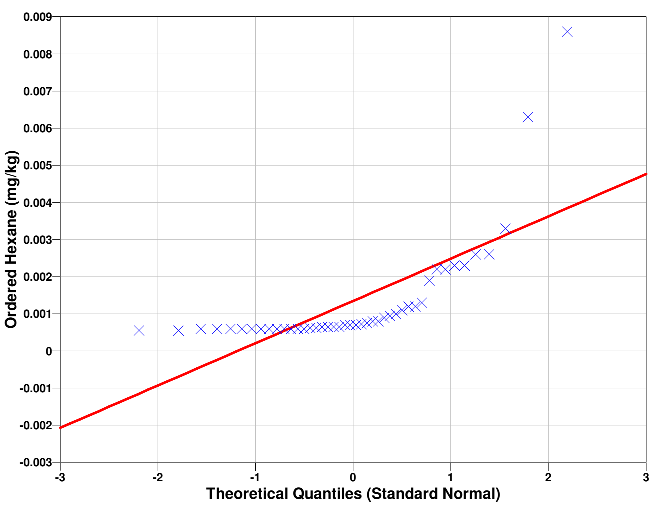
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Hexane
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5497
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.001737
95% Non-Parametric (Chebyshev) UCL	0.002358

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.002358) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.8968e+008	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Lead
The following data points were entered by the user for analysis.

Lead (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1.8	2	2.1	2.3	2.4	2.5	2.5	3.1	3.1	3.1
10	3.1	3.55	3.9	4	4	4.2	4.7	4.7	4.7	4.9
20	4.9	5.2	5.4	6.2	6.55	6.7	7.5	7.65	8.1	9.1
30	9.3	9.5	10.6	11.9	12.4	13.5	14	14.1	17.9	17.9
40	18.1	29.1	30.5	34.1						

SUMMARY STATISTICS for Lead	
n	44
Min	1.8
Max	34.1
Range	32.3
Mean	8.5648
Median	5.3
Variance	59.377
StdDev	7.7056
Std Error	1.1617
Skewness	1.8955
Interquartile Range	8.3625

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
1.8	2.025	2.35	3.212	5.3	11.57	18	30.15	34.1

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Lead			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.314	3.08	Yes

The test statistic 3.314 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Lead

1	34.1

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7895
Shapiro-Wilk 5% Critical Value	0.943

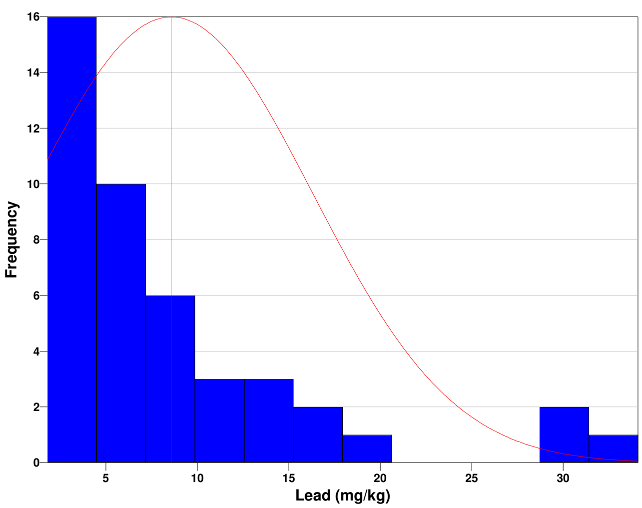
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

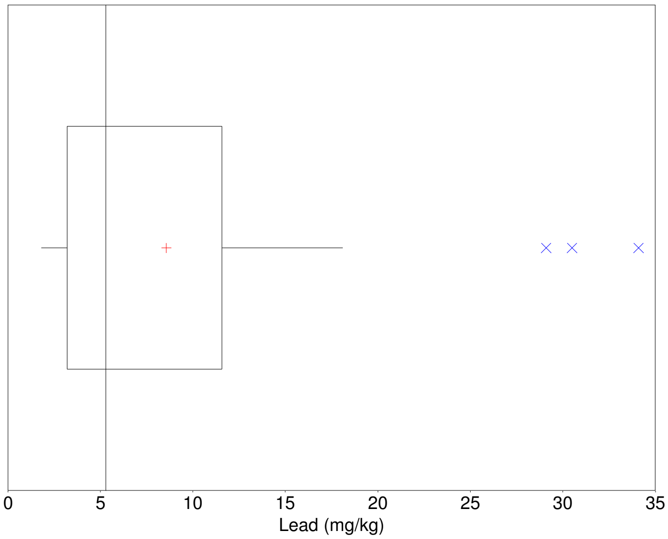
Data Plots for Lead
Graphical displays of the data are shown below.

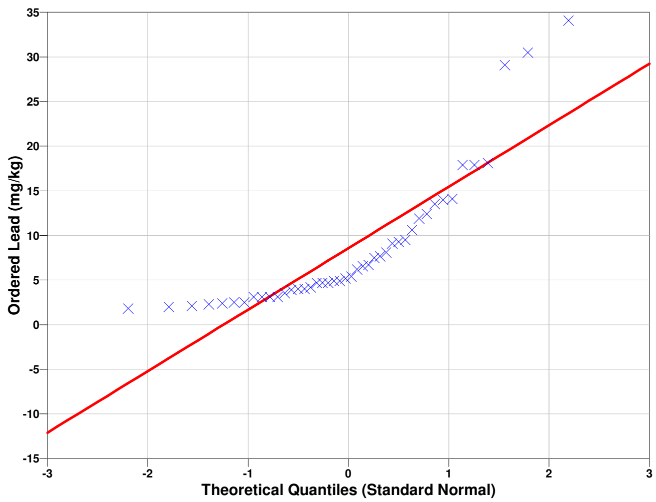
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Lead

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7669
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	10.52

95% Non-Parametric (Chebyshev) UCL	13.63

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (13.63) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-423.04	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Manganese
The following data points were entered by the user for analysis.

Manganese (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	9.5	14.1	16.4	17.9	20.2	21.7	32.2	34.7	47.7	49.4
10	54.3	54.9	55.3	58.9	59.8	60	61.1	61.6	65.1	72.3
20	72.7	75	77	79.6	91.5	95.9	97.3	98.1	101	142
30	162	168	171	177	210	241	270	304	352	398
40	427	483	504	588						

SUMMARY STATISTICS for Manganese	
n	44
Min	9.5
Max	588

Range				578.5				
Mean				142.1				
Median				76				
Variance				21567				
StdDev				146.86				
Std Error				22.14				
Skewness				1.6098				
Interquartile Range				121.05				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
9.5	14.67	19.05	54.45	76	175.5	412.5	498.8	588

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Manganese			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.036	3.08	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7771
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

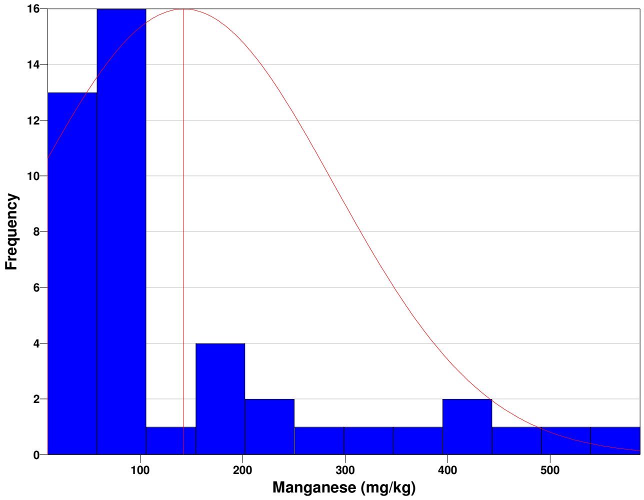
Data Plots for Manganese
Graphical displays of the data are shown below.

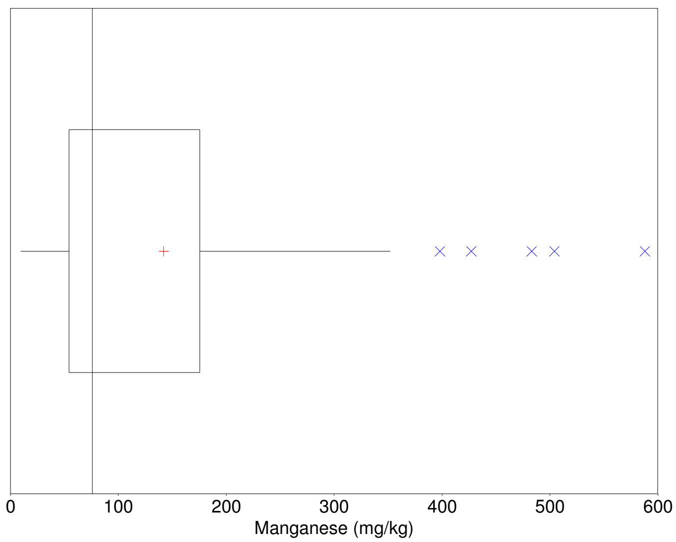
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally

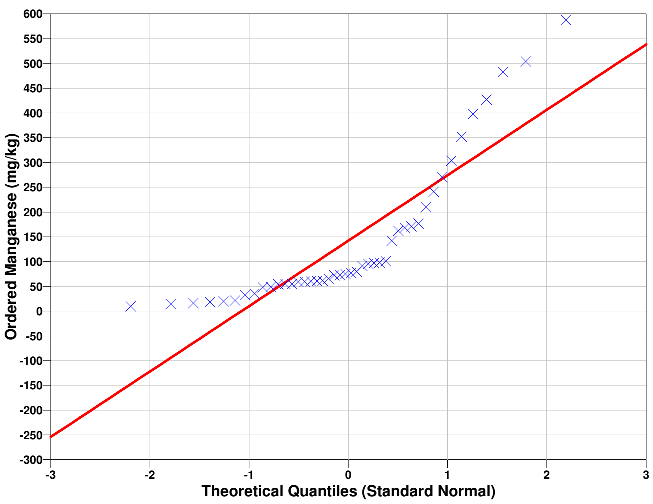
distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Manganese
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was

conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7714
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	179.3
95% Non-Parametric (Chebyshev) UCL	238.6

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (238.6) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-625.93	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Mercury
The following data points were entered by the user for analysis.

Mercury (mg/kg)

Rank	1	2	3	4	5	6	7	8	9	10
0	0.000375	0.000385	0.00041	0.0019	0.0021	0.0029	0.00335	0.0034	0.0034	0.0037
10	0.004	0.0047	0.0051	0.0051	0.0061	0.0068	0.0071	0.0072	0.00725	0.0081
20	0.0085	0.0097	0.011	0.011	0.014	0.015	0.015	0.015	0.015	0.018
30	0.018	0.019	0.021	0.021	0.022	0.025	0.027	0.029	0.031	0.032
40	0.033	0.034	0.046	0.11						

SUMMARY STATISTICS for Mercury								
n	44							
Min	0.000375							
Max	0.11							
Range	0.10963							
Mean	0.015536							
Median	0.01035							
Variance	0.00033394							
StdDev	0.018274							
Std Error	0.0027549							
Skewness	3.4436							
Interquartile Range	0.016825							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.000375	0.0003913	0.002	0.004175	0.01035	0.021	0.0325	0.043	0.11

Outlier Test

Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Mercury			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.169	3.08	Yes

The test statistic 5.169 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Mercury	
1	0.11

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the

suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8976
Shapiro-Wilk 5% Critical Value	0.943

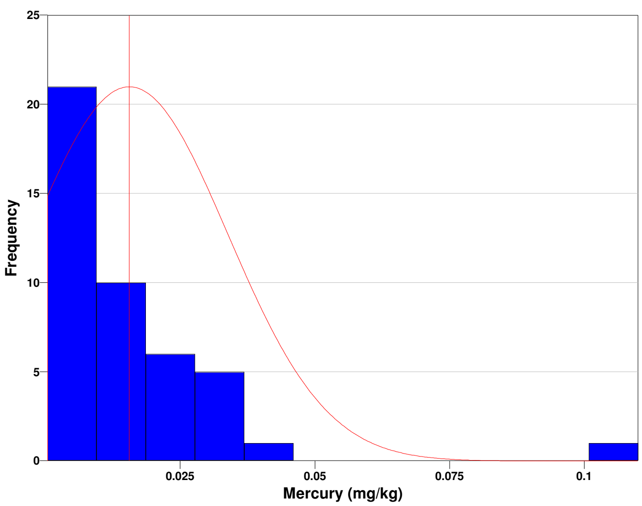
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

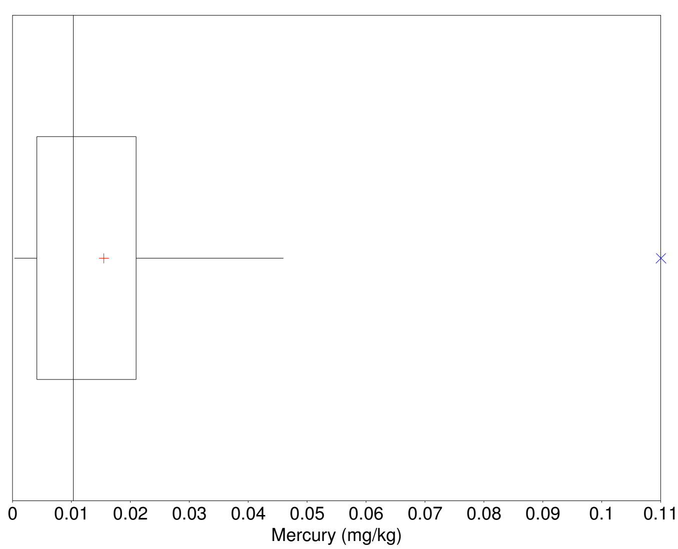
Data Plots for Mercury
Graphical displays of the data are shown below.

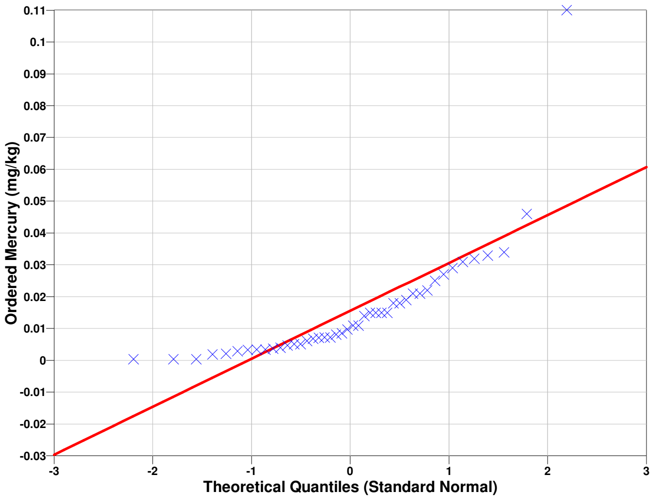
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Mercury
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6841
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.02017
95% Non-Parametric (Chebyshev) UCL	0.02754

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.02754) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-12336	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Methyl ethyl ketone
The following data points were entered by the user for analysis.

Methyl ethyl ketone (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00335	0.00345	0.00355	0.00365	0.00365	0.00375	0.00375	0.00375	0.0038	0.00383
10	0.00385	0.00385	0.00385	0.0039	0.00395	0.00395	0.00395	0.00398	0.004	0.004
20	0.00405	0.00405	0.0041	0.00415	0.00415	0.00425	0.00435	0.0045	0.0047	0.005
30	0.0055	0.006	0.0075	0.01	0.0119	0.0154	0.0165	0.0182	0.0255	0.026
40	0.0264	0.029	0.0336	0.135						

SUMMARY STATISTICS for Methyl ethyl ketone								
n	44							
Min	0.00335							
Max	0.135							
Range	0.13165							
Mean	0.011037							
Median	0.004075							
Variance	0.00043116							
StdDev	0.020764							
Std Error	0.0031303							
Skewness	5.2299							
Interquartile Range	0.005525							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00335	0.003475	0.00365	0.00385	0.004075	0.009375	0.0262	0.03245	0.135

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Methyl ethyl ketone			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.97	3.08	Yes

The test statistic 5.97 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Methyl ethyl ketone	
1	0.135

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6085
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

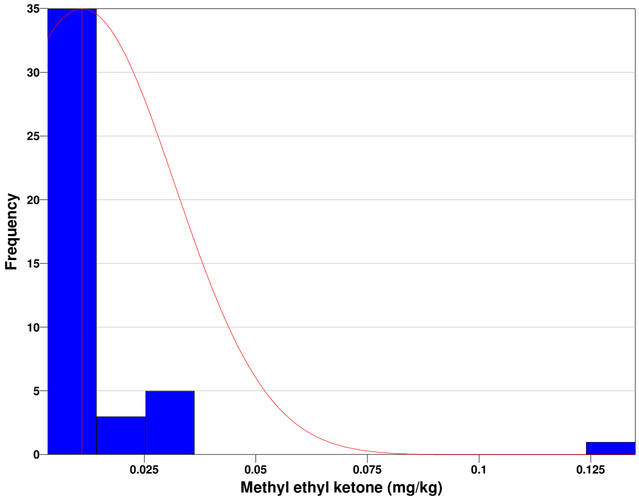
Data Plots for Methyl ethyl ketone
Graphical displays of the data are shown below.

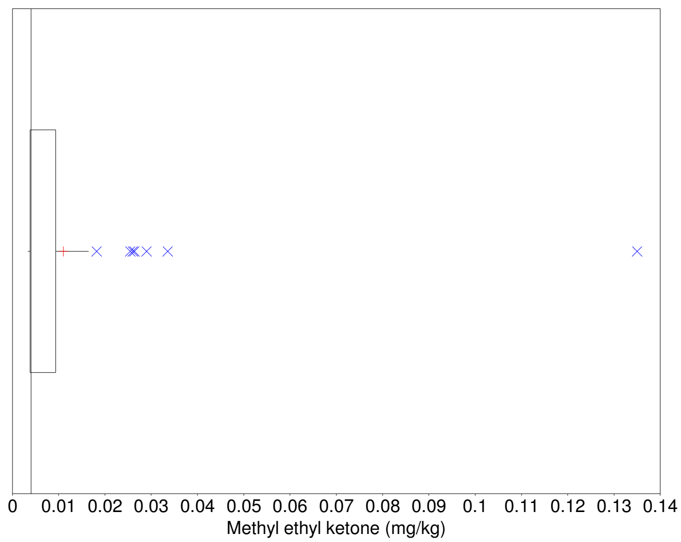
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

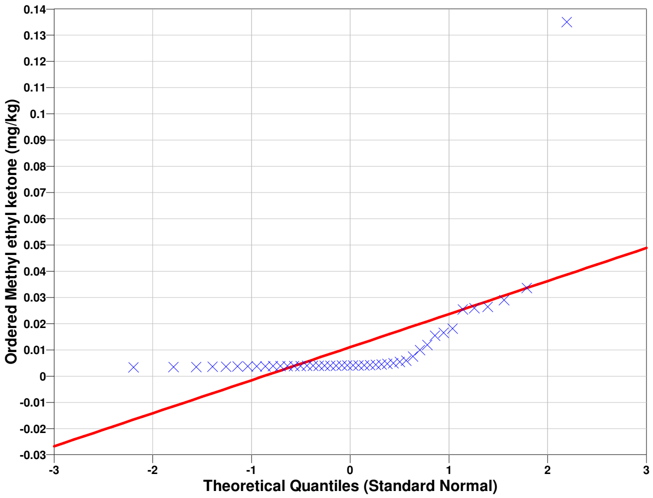
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the

Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Methyl ethyl ketone

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.3933
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.0163
95% Non-Parametric (Chebyshev) UCL	0.02468

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.02468) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.4056e+008	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Methylene chloride
The following data points were entered by the user for analysis.

Methylene chloride (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00135	0.0014	0.00143	0.00145	0.00165	0.00225	0.00275	0.0033	0.0036	0.0037
10	0.0037	0.0038	0.004	0.00405	0.0042	0.0042	0.0043	0.0043	0.0043	0.0046
20	0.0047	0.0048	0.0048	0.005	0.0052	0.0054	0.0055	0.0055	0.0057	0.0057
30	0.0057	0.0058	0.0058	0.0059	0.0063	0.0064	0.0064	0.0066	0.0069	0.007
40	0.0071	0.0079	0.008	0.0199						

SUMMARY STATISTICS for Methylene chloride	
n	44

Min				0.00135				
Max				0.0199				
Range				0.01855				
Mean				0.005053				
Median				0.0048				
Variance				8.2297e-006				
StdDev				0.0028687				
Std Error				0.00043248				
Skewness				3.1671				
Interquartile Range				0.00215				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00135	0.001407	0.00155	0.003725	0.0048	0.005875	0.00705	0.007975	0.0199

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Methylene chloride			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.175	3.08	Yes

The test statistic 5.175 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Methylene chloride	
1	0.0199

Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9566
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do appear to follow a normal distribution at the 5% level of significance.

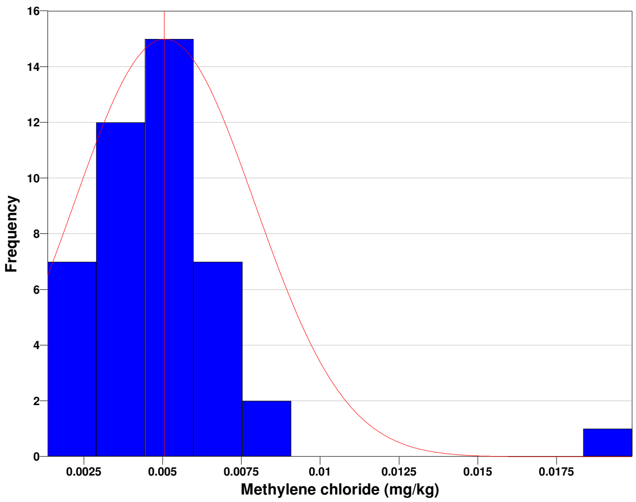
Data Plots for Methylene chloride
Graphical displays of the data are shown below.

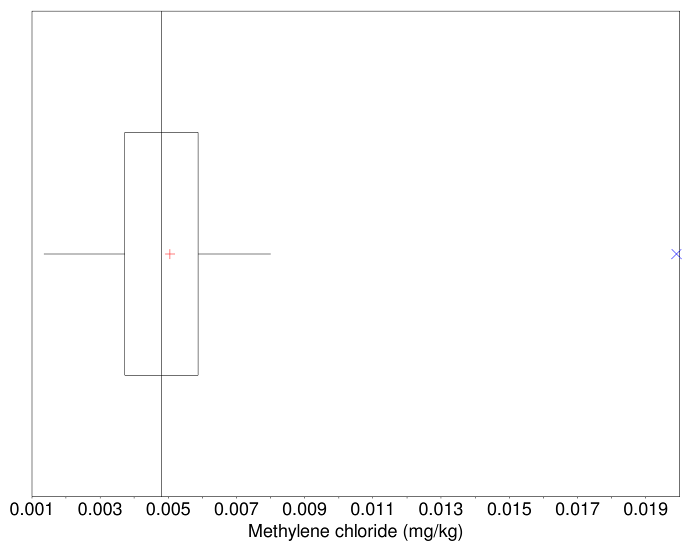
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

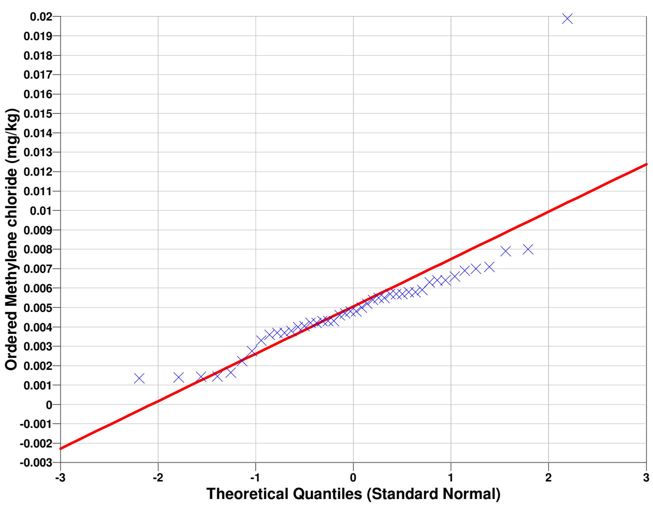
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Methylene chloride
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7343
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.00578
95% Non-Parametric (Chebyshev) UCL	0.006938

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.006938) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.6879e+007	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Nickel
The following data points were entered by the user for analysis.

Nickel (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.31	0.47	0.515	0.67	0.72	0.83	0.88	1.1	1.1	1.1
10	1.2	1.3	1.3	1.3	1.35	1.4	1.4	1.4	1.5	1.6
20	1.7	1.8	2.05	2.1	2.1	2.1	2.4	2.45	2.7	2.7
30	2.9	3.1	4.4	4.9	5.4	7.2	8	8.6	8.74	9.4
40	11.4	12.7	18.1	23.5						

SUMMARY STATISTICS for Nickel	
n	44
Min	0.31
Max	23.5
Range	23.19
Mean	3.9065
Median	1.925
Variance	23.728
StdDev	4.8712
Std Error	0.73436
Skewness	2.4111
Interquartile Range	3.55

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.31	0.4812	0.695	1.225	1.925	4.775	10.4	16.75	23.5

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Nickel			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.022	3.08	Yes

The test statistic 4.022 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Nickel

1	23.5

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7223
Shapiro-Wilk 5% Critical Value	0.943

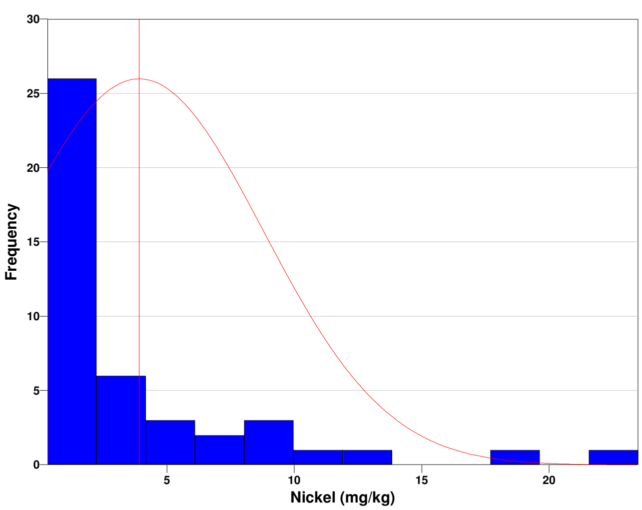
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

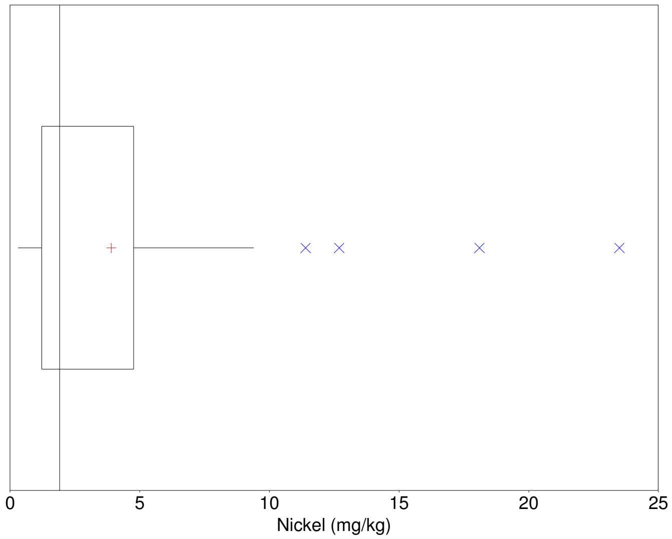
Data Plots for Nickel
Graphical displays of the data are shown below.

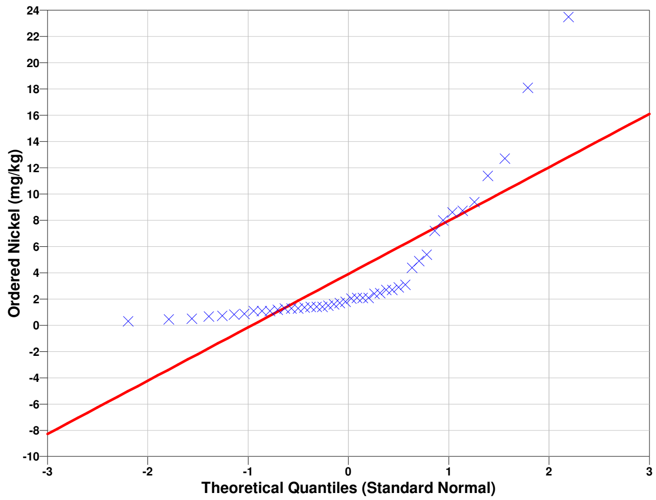
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Nickel
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6815
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	5.141

95% Non-Parametric (Chebyshev) UCL	7.107

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (7.107) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1901.1	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Selenium
The following data points were entered by the user for analysis.

Selenium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.115	0.125	0.125	0.125	0.125	0.125	0.128	0.13	0.13	0.13
10	0.13	0.13	0.135	0.135	0.135	0.135	0.135	0.135	0.14	0.14
20	0.14	0.145	0.145	0.15	0.15	0.15	0.155	0.16	0.17	0.19
30	0.21	0.27	0.28	0.28	0.31	0.34	0.34	0.39	0.445	0.47
40	1	1.07	1.2	2.2						

SUMMARY STATISTICS for Selenium	
n	44
Min	0.115
Max	2.2

Range				2.085				
Mean				0.29473				
Median				0.145				
Variance				0.1479				
StdDev				0.38457				
Std Error				0.057977				
Skewness				3.5841				
Interquartile Range				0.15				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.115	0.125	0.125	0.13	0.145	0.28	0.735	1.168	2.2

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Selenium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.954	3.08	Yes

The test statistic 4.954 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Selenium	
1	2.2

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5477
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

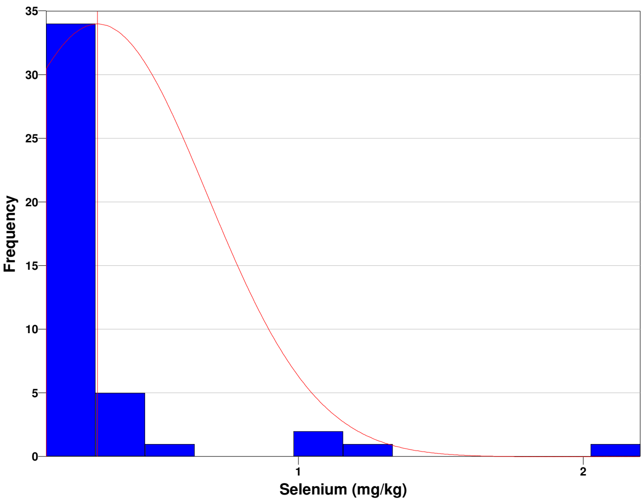
Data Plots for Selenium
Graphical displays of the data are shown below.

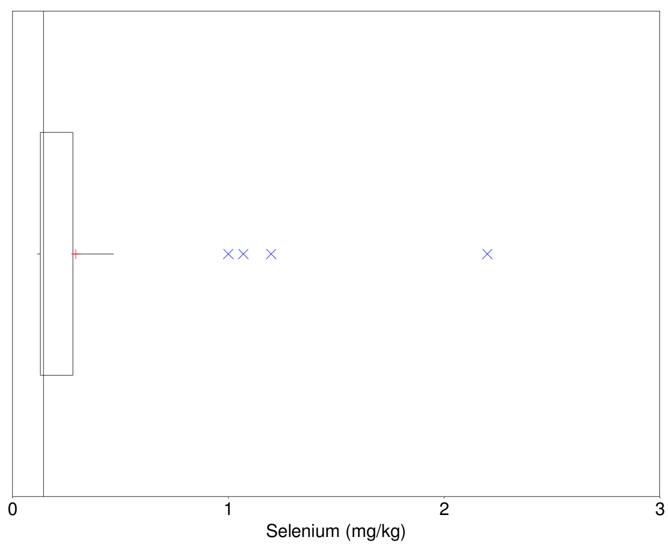
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

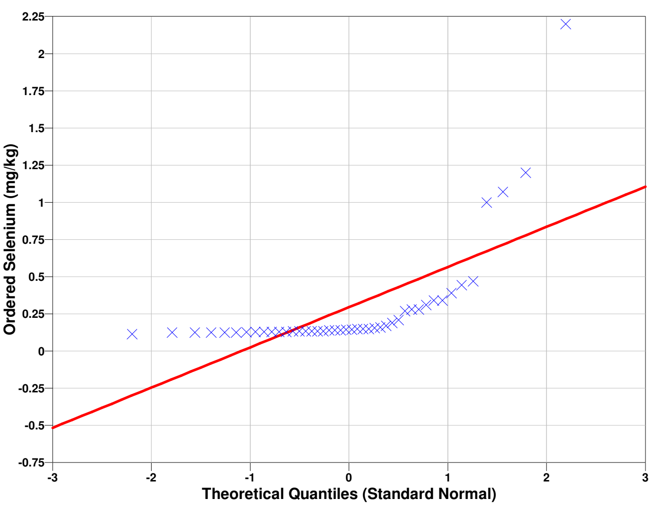
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Selenium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5016
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.3922
95% Non-Parametric (Chebyshev) UCL	0.5474

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.5474) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-46565	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Silver
The following data points were entered by the user for analysis.

Silver (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.038	0.041	0.041	0.0415	0.0415	0.042	0.042	0.042	0.0423	0.043
10	0.0435	0.0435	0.044	0.044	0.045	0.045	0.0455	0.0458	0.046	0.046
20	0.0465	0.047	0.0485	0.0485	0.049	0.0495	0.05	0.05	0.055	0.07
30	0.089	0.09	0.093	0.095	0.11	0.12	0.15	0.175	0.24	0.24
40	0.27	0.32	1.1	1.3						

SUMMARY STATISTICS for Silver	
n	44
Min	0.038
Max	1.3
Range	1.262
Mean	0.1311
Median	0.04775
Variance	0.060736
StdDev	0.24645
Std Error	0.037153
Skewness	4.0686
Interquartile Range	0.051

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.038	0.041	0.0415	0.0435	0.04775	0.0945	0.255	0.905	1.3

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Silver			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.743	3.08	Yes

The test statistic 4.743 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Silver

1	1.3

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.4055
Shapiro-Wilk 5% Critical Value	0.943

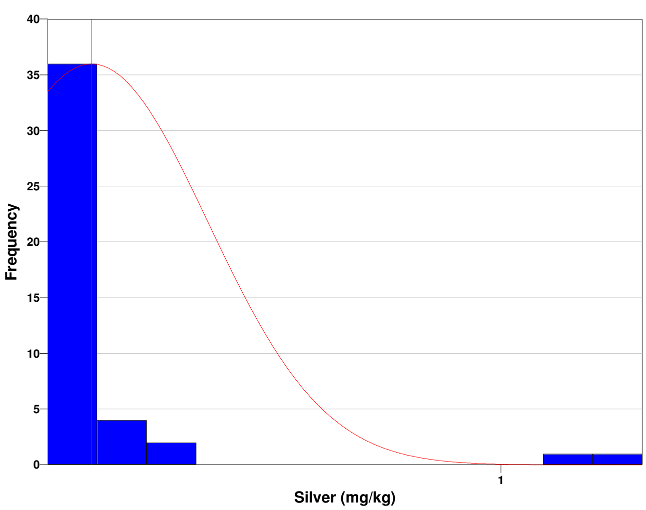
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

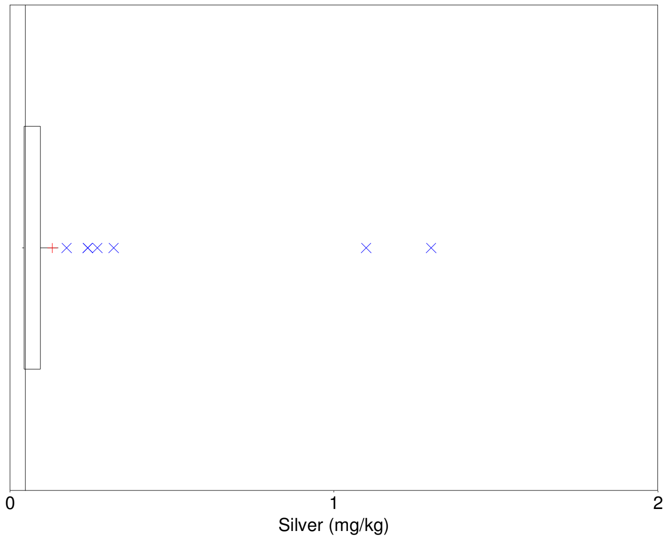
Data Plots for Silver
Graphical displays of the data are shown below.

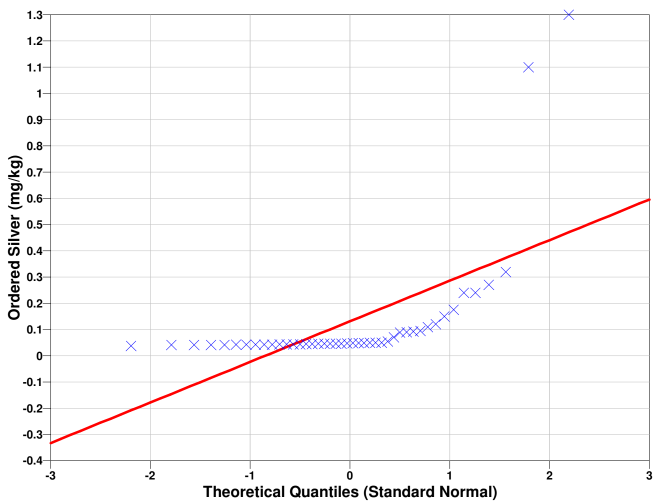
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Silver
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.4041
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.1936

95% Non-Parametric (Chebyshev) UCL	0.2931

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.2931) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-9416.9	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Toluene
The following data points were entered by the user for analysis.

Toluene (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00065	0.00065	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007
10	0.000725	0.000725	0.000725	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075
20	0.00075	0.00075	0.00075	0.0008	0.0008	0.0008	0.000825	0.0009	0.0009	0.00095
30	0.001	0.00105	0.00105	0.0011	0.00115	0.0012	0.00145	0.0022	0.0027	0.0031
40	0.00315	0.00415	0.005	0.0376						

SUMMARY STATISTICS for Toluene	
n	44
Min	0.00065
Max	0.0376

Range	0.03695
Mean	0.0020102
Median	0.00075
Variance	3.1075e-005
StdDev	0.0055745
Std Error	0.00084038
Skewness	6.3366
Interquartile Range	0.0003625

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00065	0.0006625	0.0007	0.000725	0.00075	0.001087	0.003125	0.004788	0.0376

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Toluene			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	6.384	3.08	Yes

The test statistic 6.384 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Toluene	
1	0.0376

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5618
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

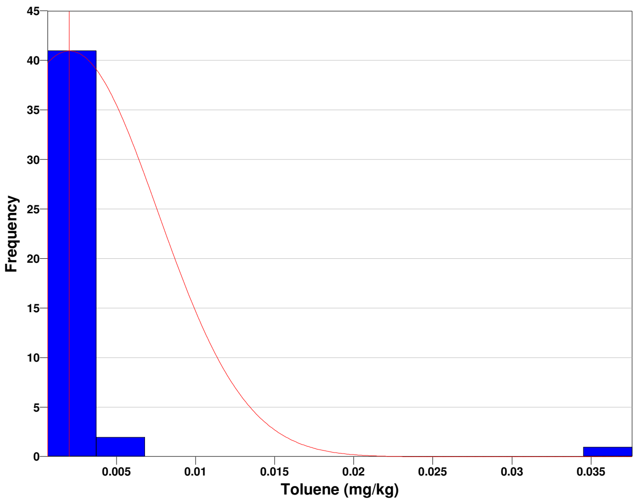
Data Plots for Toluene
Graphical displays of the data are shown below.

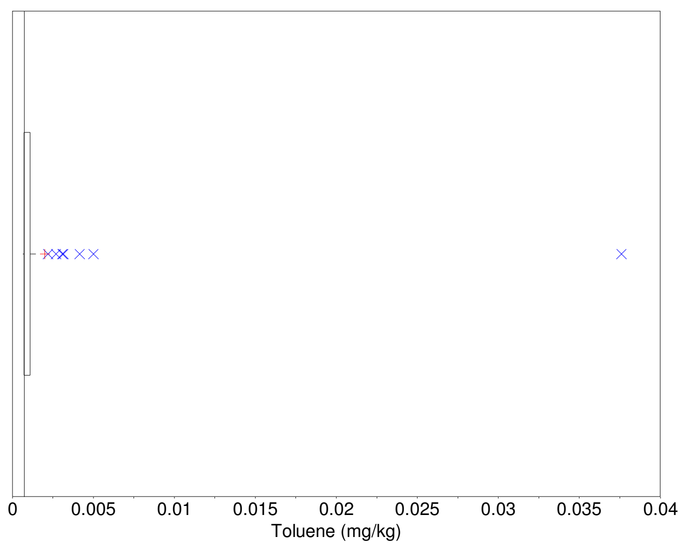
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

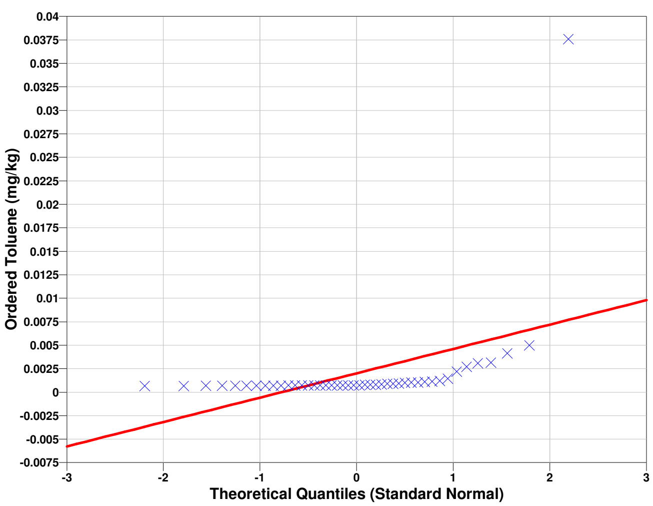
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Toluene
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.247
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.003423
95% Non-Parametric (Chebyshev) UCL	0.005673

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.005673) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-7.0206e+007	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Vanadium
The following data points were entered by the user for analysis.

Vanadium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1.2	1.5	1.6	1.65	1.9	2.5	2.65	3	3	3
10	3.5	3.6	3.6	3.8	3.8	3.95	4.1	4.8	4.8	5.1
20	5.4	5.7	6	6.1	6.2	6.4	6.6	6.7	8.2	8.3
30	8.5	9.6	10.3	13.6	16	16.1	16.8	18.8	19.8	20.7
40	25.1	39.9	48.2	58.9						

SUMMARY STATISTICS for Vanadium	
n	44
Min	1.2
Max	58.9
Range	57.7
Mean	10.249
Median	5.85
Variance	150.76
StdDev	12.279
Std Error	1.8511
Skewness	2.5561
Interquartile Range	9.25

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
1.2	1.525	1.775	3.525	5.85	12.78	22.9	46.13	58.9

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Vanadium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.962	3.08	Yes

The test statistic 3.962 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Vanadium

1	58.9

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7103
Shapiro-Wilk 5% Critical Value	0.943

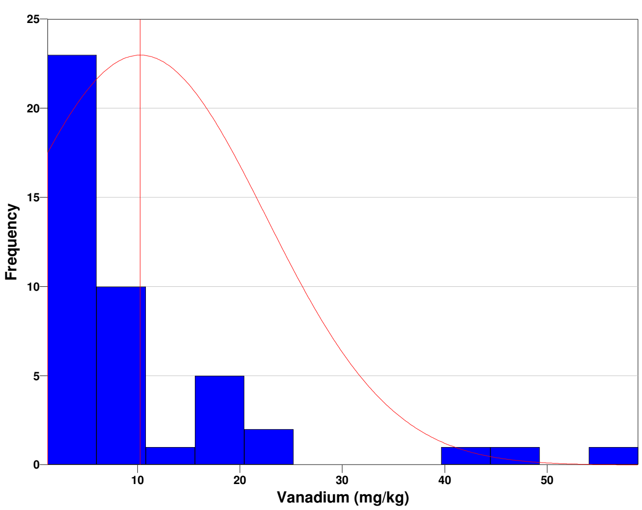
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

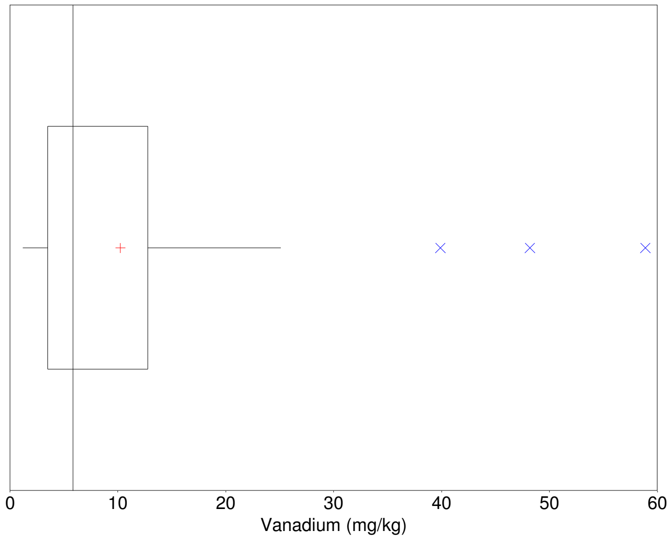
Data Plots for Vanadium
Graphical displays of the data are shown below.

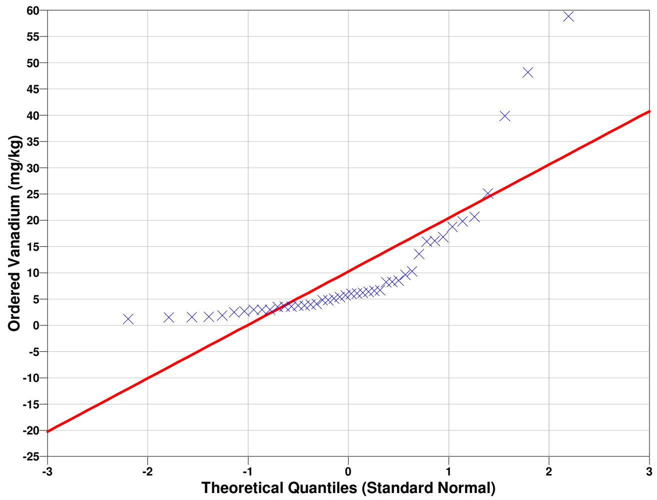
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Vanadium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6711
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	13.36

95% Non-Parametric (Chebyshev) UCL	18.32

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (18.32) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-172.74	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Zinc
The following data points were entered by the user for analysis.

Zinc (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	11.2	16.9	17.2	24.7	26.7	27	27.5	29.6	32.25	34.5
10	37.8	37.8	40	42.5	52.3	53.4	58.3	59.8	64.1	68.2
20	86.4	88.2	91.2	91.4	92.55	95.9	96	96.5	104	119
30	122	128	134	187	207	208	257.6	305	463	569
40	611	802	812	896						

SUMMARY STATISTICS for Zinc	
n	44
Min	11.2
Max	896

Range				884.8				
Mean				168.74				
Median				89.7				
Variance				51653				
StdDev				227.27				
Std Error				34.263				
Skewness				2.1447				
Interquartile Range				135.95				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
11.2	16.97	25.7	37.8	89.7	173.8	590	809.5	896

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Zinc			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.2	3.08	Yes

The test statistic 3.2 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Zinc	
1	896

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6485
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

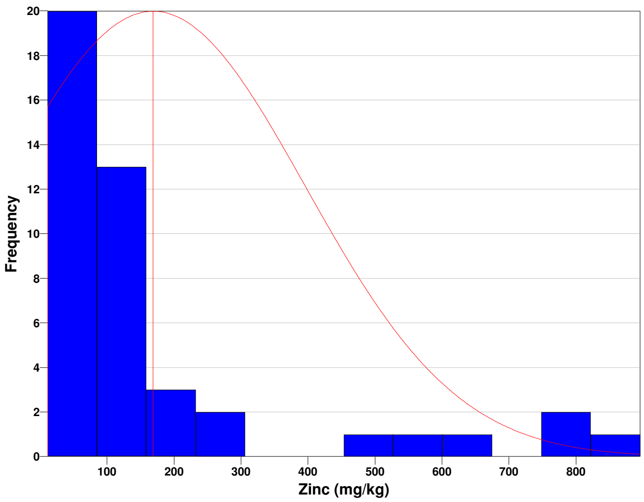
Data Plots for Zinc
Graphical displays of the data are shown below.

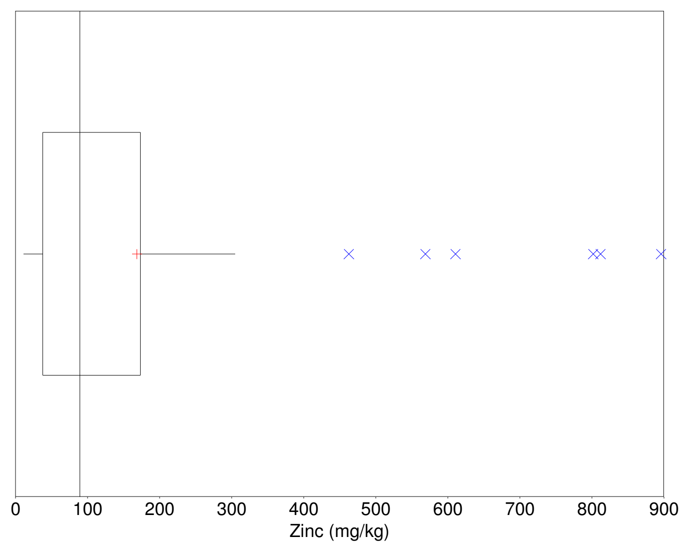
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

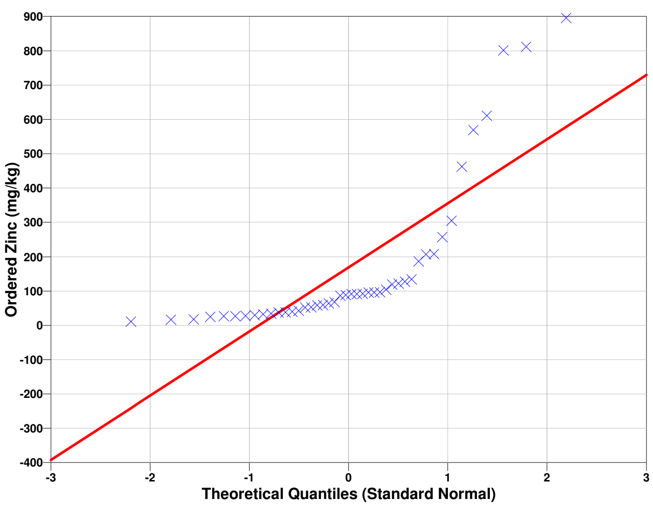
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Zinc
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6493
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	226.3
95% Non-Parametric (Chebyshev) UCL	318.1

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (318.1) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-2213.2	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Beryllium
The following data points were entered by the user for analysis.

Beryllium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.051	0.055	0.056	0.058	0.061	0.064	0.091	0.092	0.094	0.096
10	0.0965	0.098	0.1	0.1	0.1	0.11	0.11	0.12	0.125	0.13
20	0.14	0.14	0.15	0.15	0.19	0.19	0.21	0.21	0.21	0.22
30	0.225	0.23	0.257	0.4	0.42	0.43	0.47	0.49	0.52	0.58
40	0.68	0.97	1.3	1.4						

SUMMARY STATISTICS for Beryllium								
n	44							
Min	0.051							
Max	1.4							
Range	1.349							
Mean	0.27249							
Median	0.145							
Variance	0.094345							
StdDev	0.30716							
Std Error	0.046306							
Skewness	2.4037							
Interquartile Range	0.26738							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.051	0.05525	0.0595	0.09688	0.145	0.3643	0.63	1.218	1.4

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Beryllium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.671	3.08	Yes

The test statistic 3.671 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Beryllium

1	1.4

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7068
Shapiro-Wilk 5% Critical Value	0.943

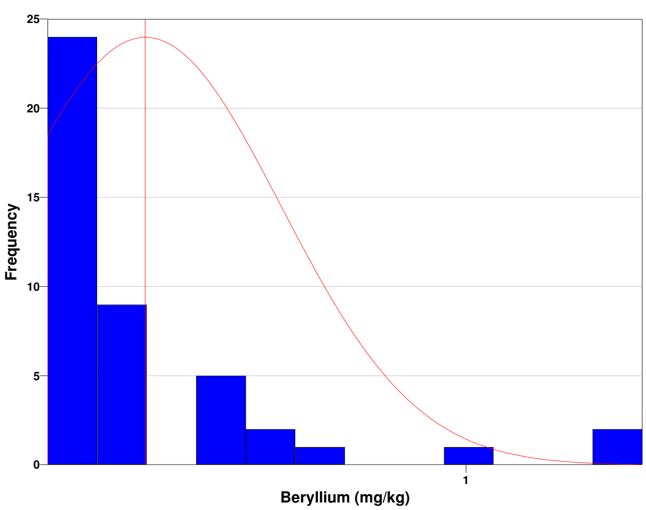
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

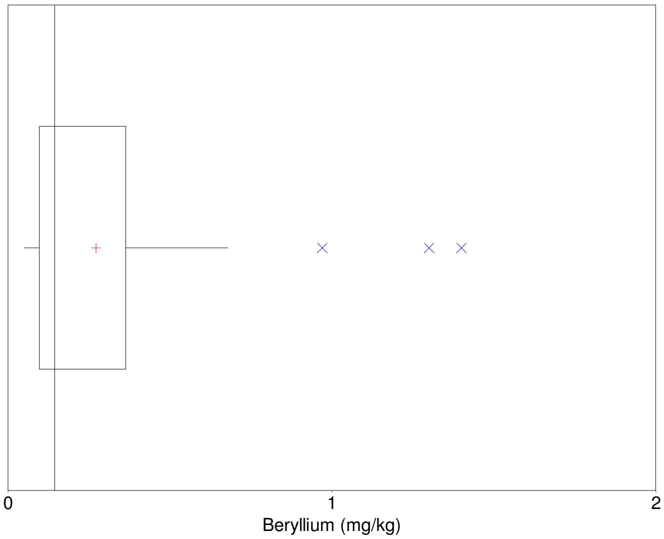
Data Plots for Beryllium
Graphical displays of the data are shown below.

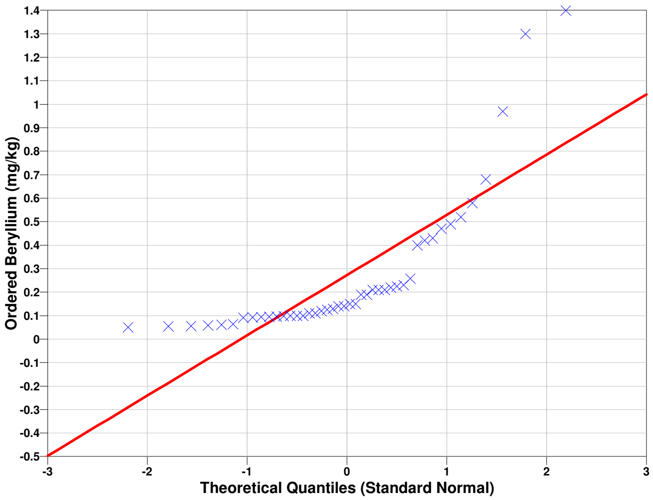
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Beryllium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6768
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.3503

95% Non-Parametric (Chebyshev) UCL	0.4743

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.4743) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (0),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-577.2	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

This report was automatically produced* by Visual Sample Plan (VSP) software version 5.3.1.
Software and documentation available at http://dqo.pnl.gov/vsp

* - The report contents may have been modified or reformatted by end-user of software.

Appendix C

VSP Reports of Calculated Minimum Sample Quantity
Report 25
Area of Concern – 3
Minimum Sample Quantity Calculation for Sediment using Ecological Benchmarks and Delta Method 1

Random sampling locations for comparing a mean with a fixed threshold (parametric)

Summary
This report summarizes the sampling design, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design for Zinc, the driving analyte (the analyte which required the largest number of samples). A figure that shows sampling locations in the field is also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean to a fixed threshold
Type of Sampling Design	Parametric
Sample Placement (Location) in the Field	Simple random sampling
Working (Null) Hypothesis	The mean value at the site exceeds the threshold
Formula for calculating number of sampling locations	Student's t-test
Calculated total number of samples	1262
Number of samples on map [a]	1262
Number of selected sample areas [b]	1
Specified sampling area [c]	602117.04 m^2
Total cost of sampling [d]	$632,000.00

[a] This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[d] Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.

Primary Sampling Objective
The primary purpose of sampling at this site is to compare a mean value of a site with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the mean value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the mean value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative hypothesis, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach
A parametric random sampling approach was used to determine the number of samples and to specify sampling locations. A parametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that parametric assumptions are reasonable. These assumptions will be examined in post-sampling data analysis.

Both parametric and non-parametric approaches rely on assumptions about the population. However, non-parametric

approaches typically require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than the number of samples required by non-parametric approaches.

Locating the sample points randomly provides data that are separated by many distances, whereas systematic samples are all equidistant apart. Therefore, random sampling provides more information about the spatial structure of the potential contamination than systematic sampling does. As with systematic sampling, random sampling also provides information regarding the mean value, but there is the possibility that areas of the site will not be represented with the same frequency as if uniform grid sampling were performed.

Number of Total Samples: Calculation Equation and Inputs
The equation used to calculate the number of samples is based on a Student's t-test. For this site, the null hypothesis is rejected in favor of the alternative hypothesis if the sample mean is sufficiently smaller than the threshold. The number of samples to collect is calculated so that 1) there will be a high probability ($1-\beta$) of rejecting the null hypothesis if the alternative hypothesis is true and 2) a low probability (α) of rejecting the null hypothesis if the null hypothesis is true.

The formula used to calculate the number of samples is:

$$n = \frac{S^2}{\Delta^2}\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2 + 0.5Z_{1-\alpha}^2$$

where
n is the number of samples,
S is the estimated standard deviation of the measured values including analytical error,
Δ is the width of the gray region,
α is the acceptable probability of incorrectly concluding the site mean is less than the threshold,
β is the acceptable probability of incorrectly concluding the site mean exceeds the threshold,
$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is $1-\alpha$,
$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is $1-\beta$.

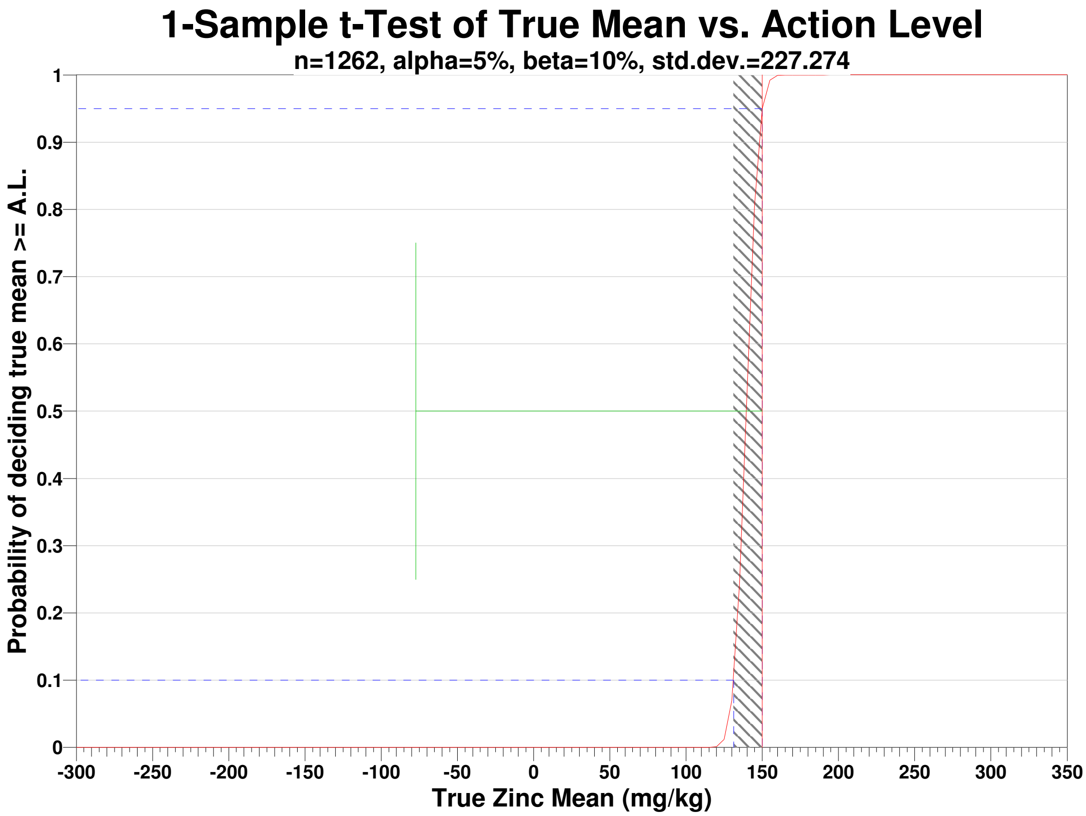
The values of these inputs that result in the calculated number of sampling locations are:

Analyte	**n**	**Parameter**					
		S	**Δ**	**α**	**β**	$Z_{1-\alpha}$ [a]	$Z_{1-\beta}$ [b]
New Location	2	0.1 mg/kg	10 mg/kg	0.05	0.1	1.64485	1.28155
Arsenic	4	2.98866 mg/kg	5.66932 mg/kg	0.05	0.1	1.64485	1.28155
bis(2-Ethylhexyl)phthalate	26	0.132826 mg/kg	0.0789006 mg/kg	0.05	0.1	1.64485	1.28155
Cadmium	2	0.133983 mg/kg	1.07966 mg/kg	0.05	0.1	1.64485	1.28155
Chromium	2	7.12413 mg/kg	74.6523 mg/kg	0.05	0.1	1.64485	1.28155
Copper	3	10.8021 mg/kg	26.4534 mg/kg	0.05	0.1	1.64485	1.28155
Lead	2	7.70564 mg/kg	38.1352 mg/kg	0.05	0.1	1.64485	1.28155
Mercury	2	0.0182741 mg/kg	0.134464 mg/kg	0.05	0.1	1.64485	1.28155
Methylene chloride	2	0.00286889 mg/kg	3.81495 mg/kg	0.05	0.1	1.64485	1.28155
Nickel	3	4.87105 mg/kg	16.9936 mg/kg	0.05	0.1	1.64485	1.28155
Silver	3	0.246449 mg/kg	0.868898 mg/kg	0.05	0.1	1.64485	1.28155
Toluene	2	0.00557446 mg/kg	0.93799 mg/kg	0.05	0.1	1.64485	1.28155
Zinc	1262	227.274 mg/kg	18.7375 mg/kg	0.05	0.1	1.64485	1.28155

[a] This value is automatically calculated by VSP based upon the user defined value of α.
[b] This value is automatically calculated by VSP based upon the user defined value of β.

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000) for Zinc, the driving analyte. It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true mean values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at 1-α on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at 1-α. If any of the inputs change, the number of samples that result in the correct curve changes.



Statistical Assumptions
The assumptions associated with the formulas for computing the number of samples are:

1. the sample mean is normally distributed (this happens if the data are roughly symmetric or the sample size is more than 30; for extremely skewed data sets, additional samples may be required for the sample mean to be normally distributed),
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected randomly.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the sample locations were selected using a random process.

Sensitivity Analysis
The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that μ > action level and alpha (%), probability of mistakenly concluding that μ < action level. The following table shows the results of this analysis.

Number of Samples							
AL=150		α=5		α=10		α=15	
		s=454.548	s=227.274	s=454.548	s=227.274	s=454.548	s=227.274
LBGR=90	β=5	9940	2486	7865	1967	6603	1651

	β=10	7866	1968	6034	1509	4935	1235
	β=15	6604	1652	4935	1235	3947	987
LBGR=80	β=5	2486	623	1967	493	1651	414
	β=10	1968	493	1509	378	1235	309
	β=15	1652	414	1235	310	987	248
LBGR=70	β=5	1106	278	875	220	735	184
	β=10	876	220	672	169	549	138
	β=15	735	185	550	138	439	111

s = Standard Deviation
LBGR = Lower Bound of Gray Region (% of Action Level)
β = Beta (%), Probability of mistakenly concluding that μ > action level
α = Alpha (%), Probability of mistakenly concluding that μ < action level
AL = Action Level (Threshold)

Cost of Sampling
The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that are based on the number of samples collected and measured. Based on the numbers of samples determined above, the estimated total cost of sampling and analysis at this site is $632,000.00, which averages out to a per sample cost of $500.79. The following table summarizes the inputs and resulting cost estimates.

COST INFORMATION			
Cost Details	**Per Analysis**	**Per Sample**	**1262 Samples**
Field collection costs		$100.00	$126,200.00
Analytical costs	$400.00	$400.00	$504,800.00
Sum of Field & Analytical costs		**$500.00**	**$631,000.00**
Fixed planning and validation costs			$1,000.00
Total cost			**$632,000.00**

Data Analysis for New Location

SUMMARY STATISTICS for New Location	
n	1218
Min	0
Max	0
Range	0
Mean	0
Median	0
Variance	0
StdDev	0
Std Error	0
Skewness	-1.#IND
Interquartile Range	0

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**

0	0	0	0	0	0	0	0	0	0

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for New Location			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	-1.#IO	2.99	No

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Lilliefors test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Lilliefors Test Statistic	0
Lilliefors 5% Critical Value	0.934

The calculated Lilliefors test statistic is less than the 5% Lilliefors critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

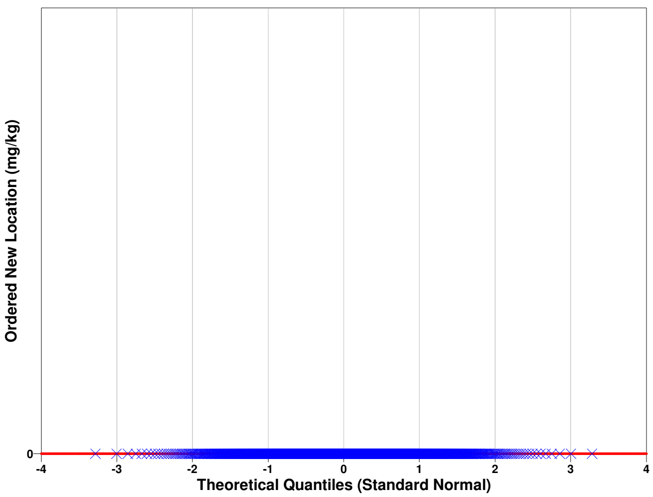
Data Plots for New Location
Graphical displays of the data are shown below.

The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a

fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.



For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for New Location
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Lilliefors test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Lilliefors Test Statistic	0
Lilliefors 5% Critical Value	0.02539

The calculated Lilliefors test statistic is less than the 5% Lilliefors critical value, so we cannot reject the hypothesis that the data are normal, or in other words the data appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN

95% Parametric UCL	0
95% Non-Parametric (Chebyshev) UCL	0

Because the data appear to be normally distributed according to the goodness-of-fit test performed above, the parametric UCL (0) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=1218 data,
AL is the action level or threshold (150),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=1217 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.#IND	1.6461	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Data Analysis for Arsenic
The following data points were entered by the user for analysis.

Arsenic (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.31	0.33	0.43	0.45	0.455	0.625	0.67	0.74	0.75	0.75
10	0.79	0.86	0.86	1.1	1.3	1.3	1.4	1.4	1.4	1.5
20	1.5	1.5	1.6	1.6	1.6	1.7	1.7	2.13	2.2	2.3
30	2.4	2.4	2.6	2.8	2.8	3.3	4.7	4.8	5	6.3
40	6.3	6.5	8.9	17.3						

SUMMARY STATISTICS for Arsenic	
n	44
Min	0.31
Max	17.3
Range	16.99
Mean	2.5307
Median	1.55
Variance	8.9321
StdDev	2.9887

Std Error				0.45056				
Skewness				3.2631				
Interquartile Range				1.9425				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.31	0.355	0.4525	0.8075	1.55	2.75	6.3	8.3	17.3

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Arsenic			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.942	3.08	Yes

The test statistic 4.942 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Arsenic	
1	17.3

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.794
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

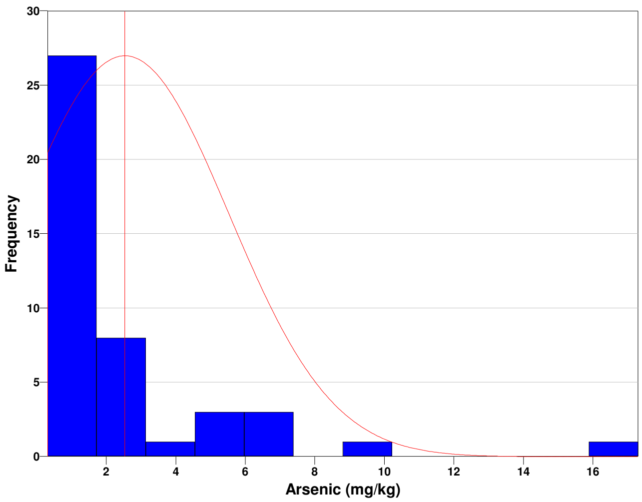
Data Plots for Arsenic
Graphical displays of the data are shown below.

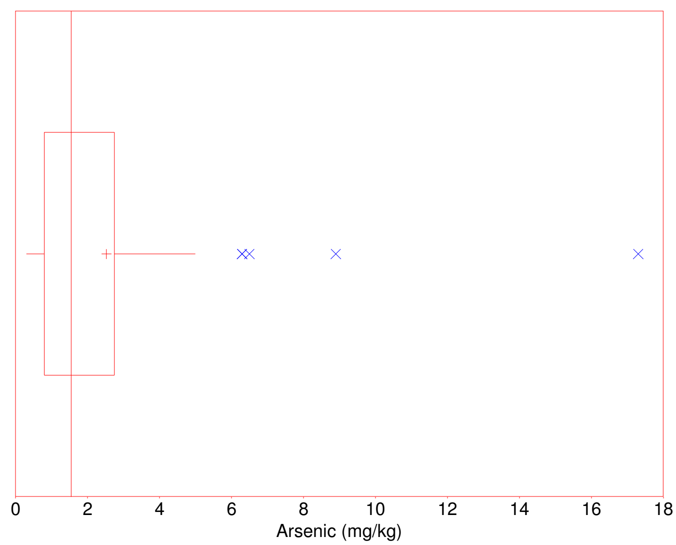
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

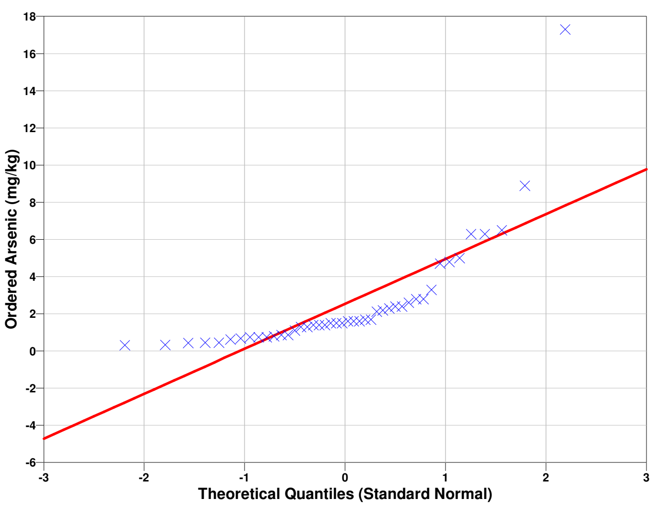
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box,

called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Arsenic

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST

Shapiro-Wilk Test Statistic	0.6543
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	3.288
95% Non-Parametric (Chebyshev) UCL	4.495

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (4.495) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (150),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-12.583	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
42	27	Reject

Data Analysis for bis(2-Ethylhexyl)phthalate
The following data points were entered by the user for analysis.

bis(2-Ethylhexyl)phthalate (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

0	0.046	0.0465	0.047	0.0479	0.048	0.0483	0.0485	0.0485	0.0485	0.049
10	0.0495	0.0495	0.0498	0.05	0.05	0.05	0.05	0.0525	0.055	0.055
20	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.06	0.06	0.065
30	0.065	0.065	0.065	0.075	0.085	0.095	0.1	0.136	0.153	0.215
40	0.342	0.408	0.444	0.729						

SUMMARY STATISTICS for bis(2-Ethylhexyl)phthalate								
n	44							
Min	0.046							
Max	0.729							
Range	0.683							
Mean	0.1031							
Median	0.055							
Variance	0.017642							
StdDev	0.13282							
Std Error	0.020024							
Skewness	3.3692							
Interquartile Range	0.023							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.046	0.04663	0.04795	0.0495	0.055	0.0725	0.2785	0.435	0.729

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for bis(2-Ethylhexyl)phthalate			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.712	3.08	Yes

The test statistic 4.712 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for bis(2-Ethylhexyl)phthalate	
1	0.729

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.4909
Shapiro-Wilk 5% Critical Value	0.943

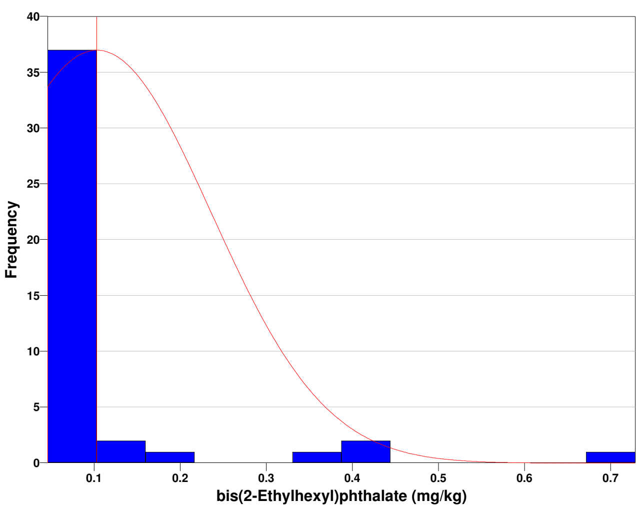
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

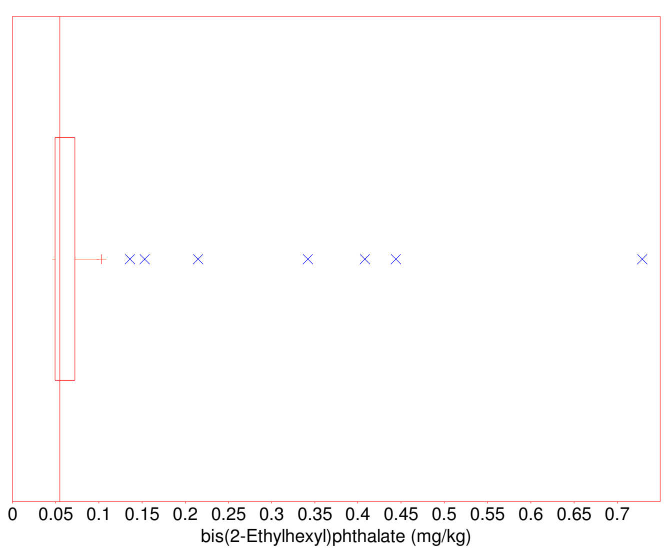
Data Plots for bis(2-Ethylhexyl)phthalate
Graphical displays of the data are shown below.

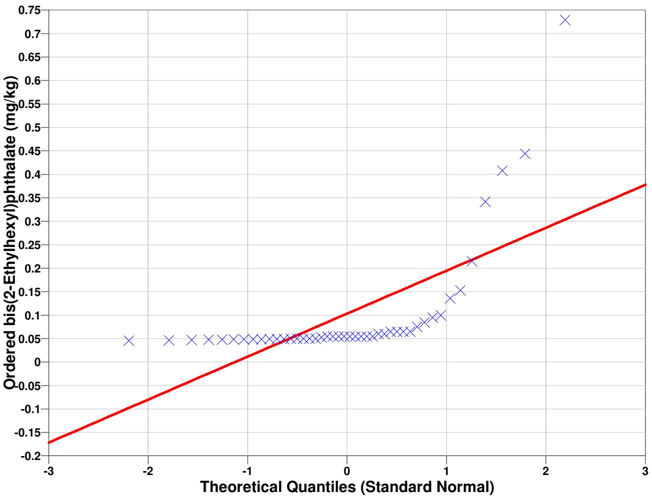
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for bis(2-Ethylhexyl)phthalate
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.4804
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.1368
95% Non-Parametric (Chebyshev) UCL	0.1904

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.1904) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (150),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-3.9401	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
39	27	Reject

Data Analysis for Cadmium
The following data points were entered by the user for analysis.

Cadmium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0475	0.048	0.05	0.05	0.05	0.05	0.052	0.055	0.055	0.055
10	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.0575
20	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.065	0.065	0.065
30	0.07	0.09	0.115	0.115	0.12	0.2	0.21	0.235	0.25	0.32
40	0.33	0.41	0.48	0.67						

SUMMARY STATISTICS for Cadmium								
n	44							
Min	0.0475							
Max	0.67							
Range	0.6225							
Mean	0.12034							
Median	0.06							
Variance	0.017952							
StdDev	0.13398							
Std Error	0.020199							
Skewness	2.5395							
Interquartile Range	0.06							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0475	0.0485	0.05	0.055	0.06	0.115	0.325	0.4625	0.67

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Cadmium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.102	3.08	Yes

The test statistic 4.102 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Cadmium	
1	0.67

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6044
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

Data Plots for Cadmium
Graphical displays of the data are shown below.

The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

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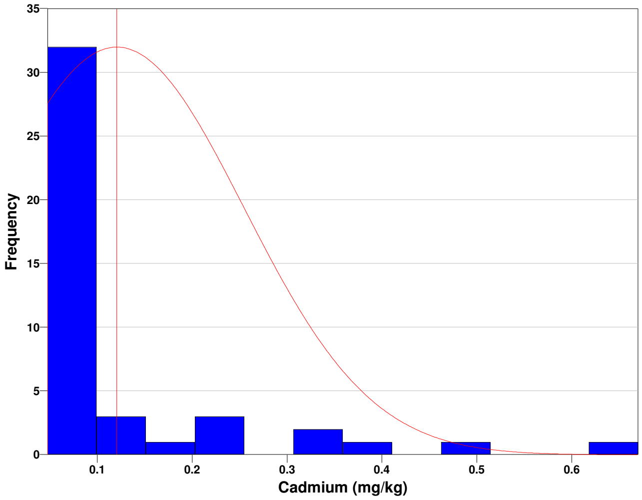
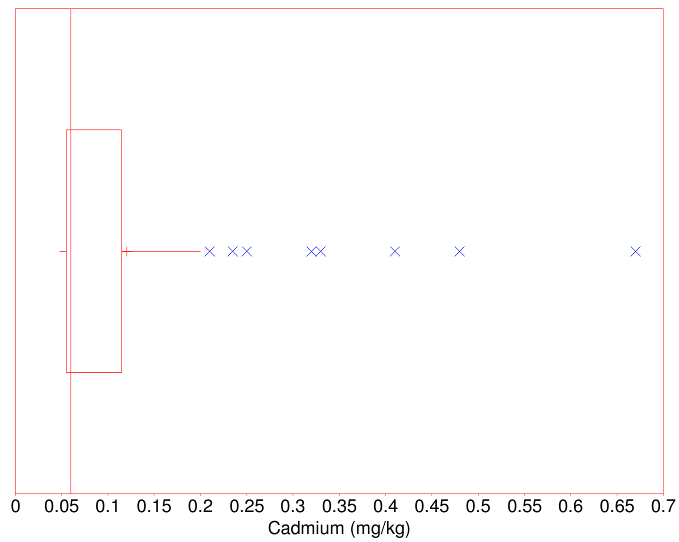
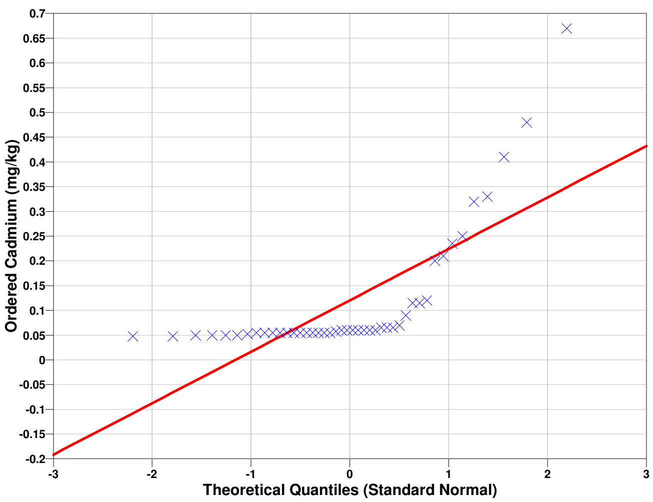
The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the

Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Cadmium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5927
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.1543
95% Non-Parametric (Chebyshev) UCL	0.2084

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.2084) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (150),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-53.452	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Chromium
The following data points were entered by the user for analysis.

Chromium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1.1	1.2	1.2	1.3	1.35	1.6	1.9	2	2	2.1
10	2.2	2.3	2.35	2.4	2.4	2.4	2.4	2.5	2.7	2.9
20	2.9	3.3	3.3	3.3	3.5	4.2	4.2	4.45	4.5	4.7
30	5.7	6.3	7.55	7.6	9.2	9.4	11.8	13.6	14.6	14.9
40	17.4	23.8	28.9	29.9						

SUMMARY STATISTICS for Chromium	
n	44

Min	1.1
Max	29.9
Range	28.8
Mean	6.3477
Median	3.3
Variance	50.753
StdDev	7.1241
Std Error	1.074
Skewness	2.0955
Interquartile Range	5.3625

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
1.1	1.2	1.325	2.225	3.3	7.587	16.15	27.63	29.9

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Chromium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.306	3.08	Yes

The test statistic 3.306 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Chromium	
1	29.9

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7122
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

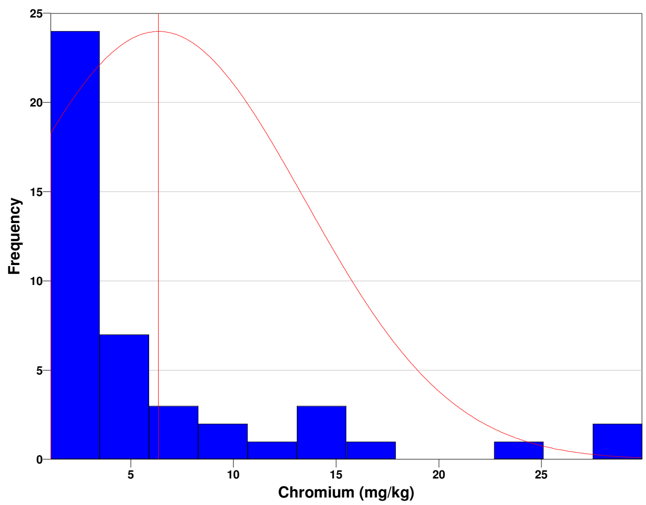
Data Plots for Chromium

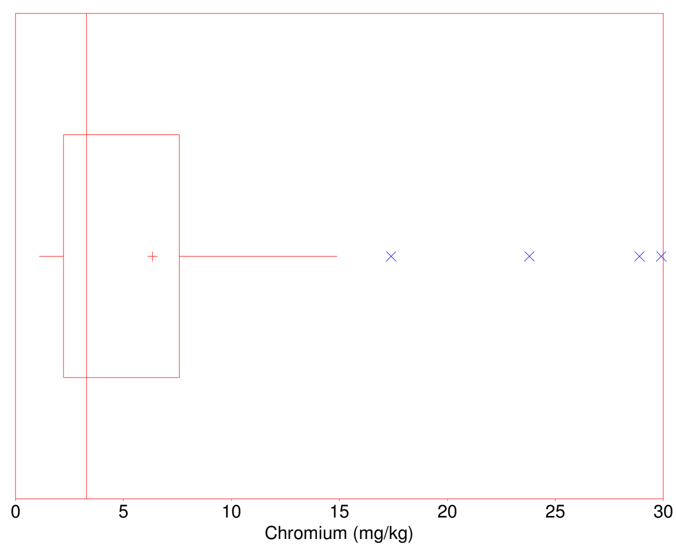
Graphical displays of the data are shown below.

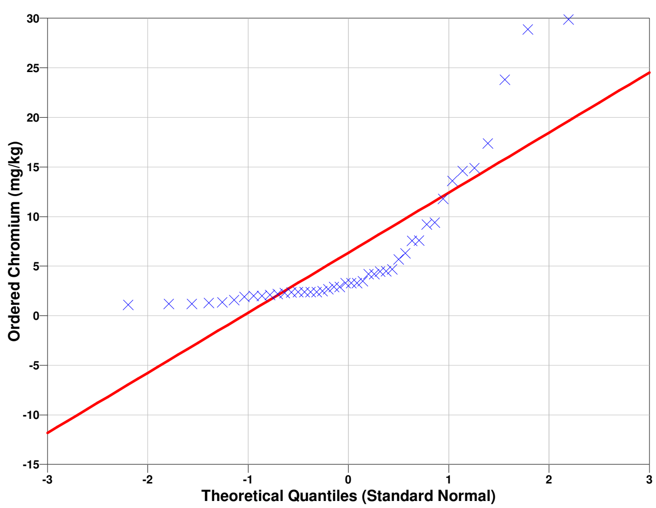
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Chromium
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6948
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	8.153
95% Non-Parametric (Chebyshev) UCL	11.03

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (11.03) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (150),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-69.508	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**

44	27	Reject

Data Analysis for Copper
The following data points were entered by the user for analysis.

Copper (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1.1	1.1	1.1	1.1	1.1	1.3	1.5	1.5	1.8	1.9
10	1.9	2.1	2.1	2.2	2.5	2.5	2.5	2.6	2.8	2.8
20	2.9	2.95	3.25	3.3	3.3	3.5	3.6	4.1	4.2	4.4
30	4.6	5.3	7.1	7.7	8	12.1	15.9	19.3	20.7	21.2
40	23	24.9	32.2	57.1						

SUMMARY STATISTICS for Copper								
n	44							
Min	1.1							
Max	57.1							
Range	56							
Mean	7.5477							
Median	3.1							
Variance	116.7							
StdDev	10.803							
Std Error	1.6286							
Skewness	2.8641							
Interquartile Range	5.6							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
1.1	1.1	1.1	1.95	3.1	7.55	22.1	30.38	57.1

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Copper			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.587	3.08	Yes

The test statistic 4.587 exceeded the corresponding critical value, therefore that test is significant and we conclude that the

most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Copper	
1	57.1

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6764
Shapiro-Wilk 5% Critical Value	0.943

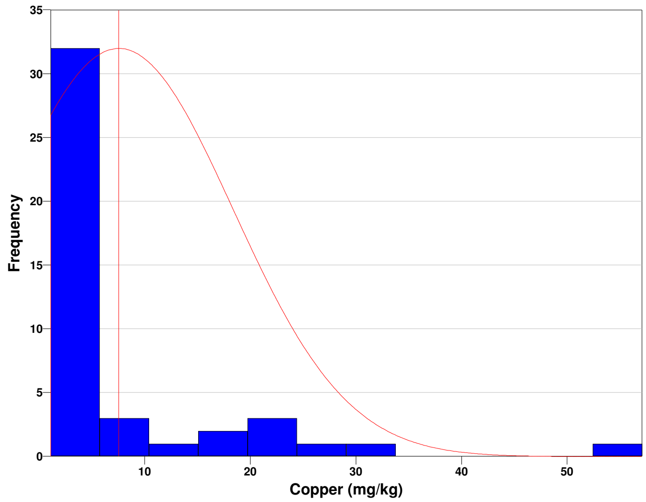
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

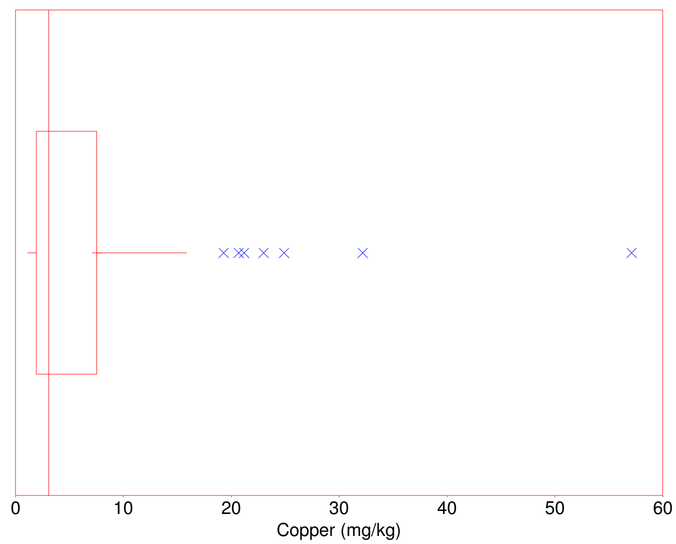
Data Plots for Copper
Graphical displays of the data are shown below.

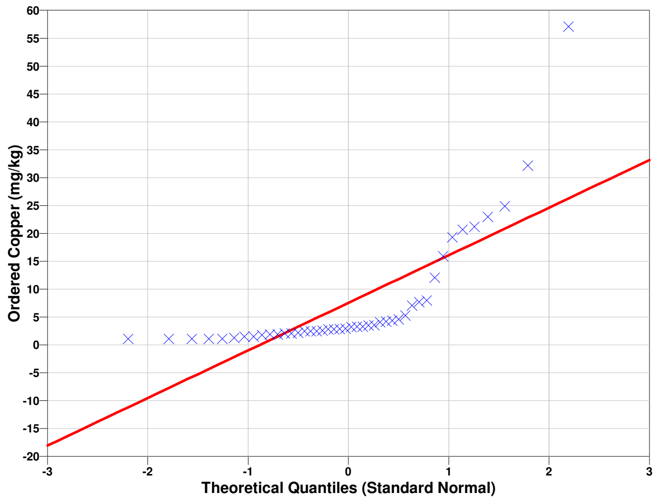
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Copper

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.62
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	10.29

95% Non-Parametric (Chebyshev) UCL	14.65

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (14.65) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (150),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-16.242	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
43	27	Reject

Data Analysis for Lead
The following data points were entered by the user for analysis.

Lead (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1.8	2	2.1	2.3	2.4	2.5	2.5	3.1	3.1	3.1
10	3.1	3.55	3.9	4	4	4.2	4.7	4.7	4.7	4.9
20	4.9	5.2	5.4	6.2	6.55	6.7	7.5	7.65	8.1	9.1
30	9.3	9.5	10.6	11.9	12.4	13.5	14	14.1	17.9	17.9
40	18.1	29.1	30.5	34.1						

SUMMARY STATISTICS for Lead	
n	44
Min	1.8
Max	34.1

Range				32.3				
Mean				8.5648				
Median				5.3				
Variance				59.377				
StdDev				7.7056				
Std Error				1.1617				
Skewness				1.8955				
Interquartile Range				8.3625				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
1.8	2.025	2.35	3.212	5.3	11.57	18	30.15	34.1

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Lead			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.314	3.08	Yes

The test statistic 3.314 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Lead	
1	34.1

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7895
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

Data Plots for Lead
Graphical displays of the data are shown below.

The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

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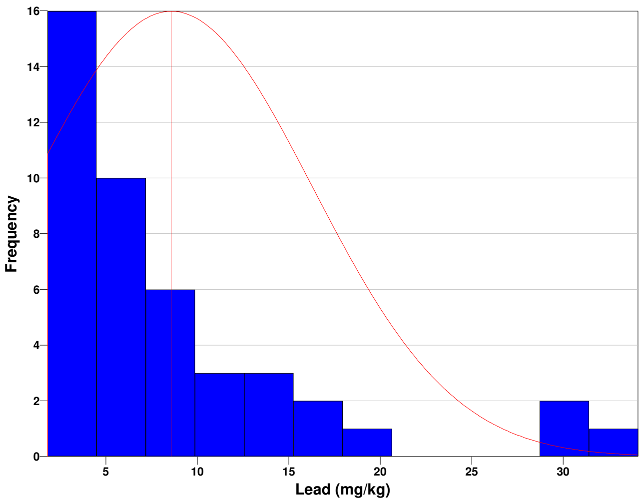
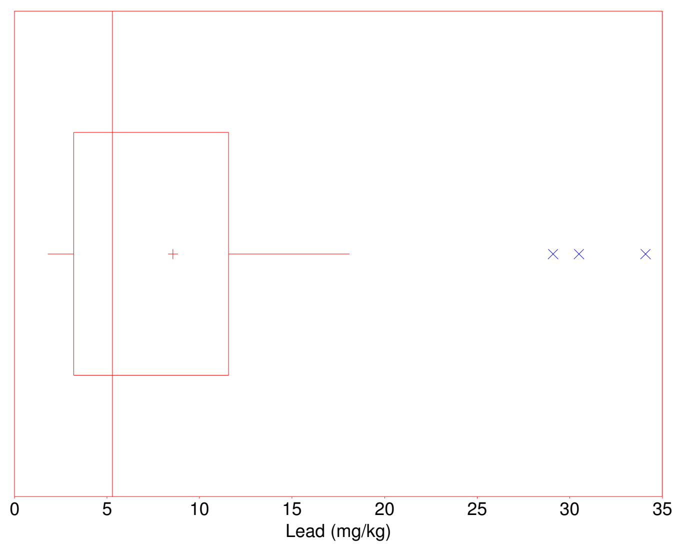
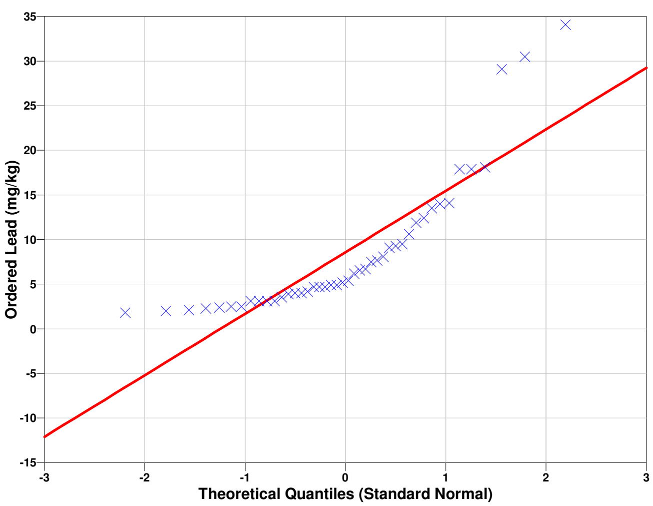
The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Lead
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7669
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	10.52
95% Non-Parametric (Chebyshev) UCL	13.63

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (13.63) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (150),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-32.828	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Mercury
The following data points were entered by the user for analysis.

Mercury (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.000375	0.000385	0.00041	0.0019	0.0021	0.0029	0.00335	0.0034	0.0034	0.0037
10	0.004	0.0047	0.0051	0.0051	0.0061	0.0068	0.0071	0.0072	0.00725	0.0081
20	0.0085	0.0097	0.011	0.011	0.014	0.015	0.015	0.015	0.015	0.018
30	0.018	0.019	0.021	0.021	0.022	0.025	0.027	0.029	0.031	0.032
40	0.033	0.034	0.046	0.11						

SUMMARY STATISTICS for Mercury								
n	44							
Min	0.000375							
Max	0.11							
Range	0.10963							
Mean	0.015536							
Median	0.01035							
Variance	0.00033394							
StdDev	0.018274							
Std Error	0.0027549							
Skewness	3.4436							
Interquartile Range	0.016825							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.000375	0.0003913	0.002	0.004175	0.01035	0.021	0.0325	0.043	0.11

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Mercury			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.169	3.08	Yes

The test statistic 5.169 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Mercury

1	0.11

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8976
Shapiro-Wilk 5% Critical Value	0.943

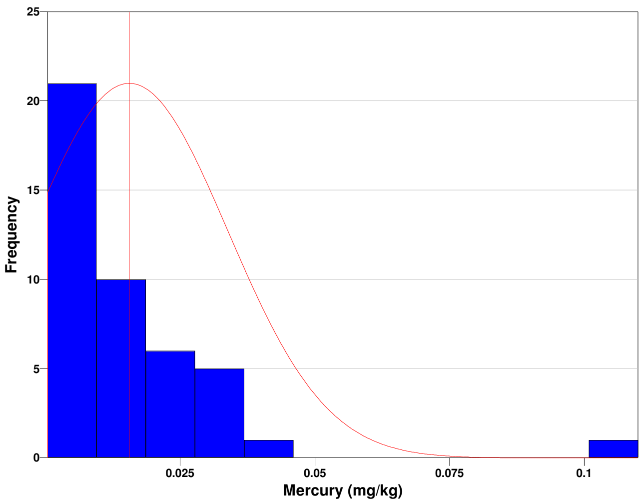
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

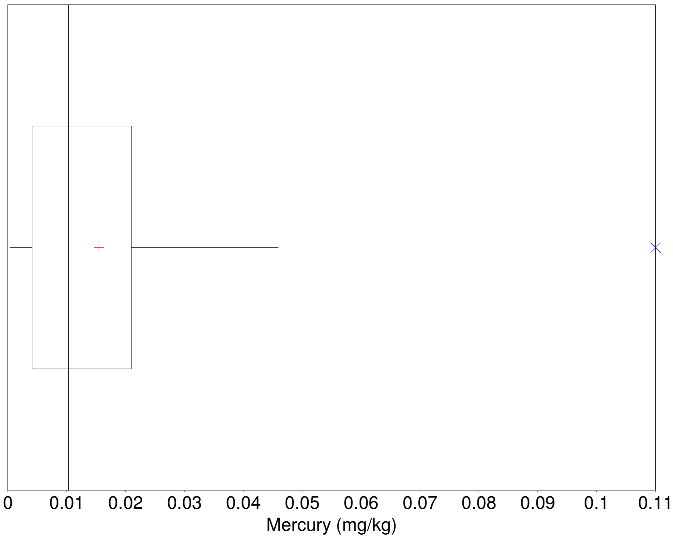
Data Plots for Mercury
Graphical displays of the data are shown below.

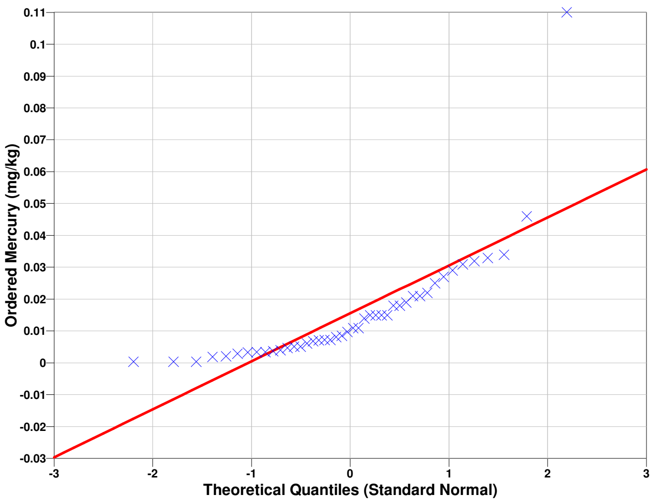
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Mercury

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6841
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.02017

95% Non-Parametric (Chebyshev) UCL	0.02754

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.02754) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (150),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-48.809	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Methylene chloride
The following data points were entered by the user for analysis.

Methylene chloride (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00135	0.0014	0.00143	0.00145	0.00165	0.00225	0.00275	0.0033	0.0036	0.0037
10	0.0037	0.0038	0.004	0.00405	0.0042	0.0042	0.0043	0.0043	0.0043	0.0046
20	0.0047	0.0048	0.0048	0.005	0.0052	0.0054	0.0055	0.0055	0.0057	0.0057
30	0.0057	0.0058	0.0058	0.0059	0.0063	0.0064	0.0064	0.0066	0.0069	0.007
40	0.0071	0.0079	0.008	0.0199						

SUMMARY STATISTICS for Methylene chloride	
n	44
Min	0.00135
Max	0.0199

Range	0.01855							
Mean	0.005053							
Median	0.0048							
Variance	8.2297e-006							
StdDev	0.0028687							
Std Error	0.00043248							
Skewness	3.1671							
Interquartile Range	0.00215							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00135	0.001407	0.00155	0.003725	0.0048	0.005875	0.00705	0.007975	0.0199

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Methylene chloride			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.175	3.08	Yes

The test statistic 5.175 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Methylene chloride	
1	0.0199

Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9566
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do appear to follow a normal distribution at the 5% level of significance.

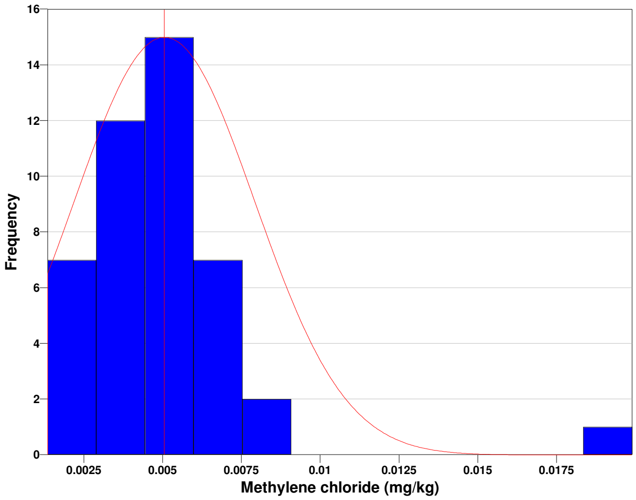
Data Plots for Methylene chloride
Graphical displays of the data are shown below.

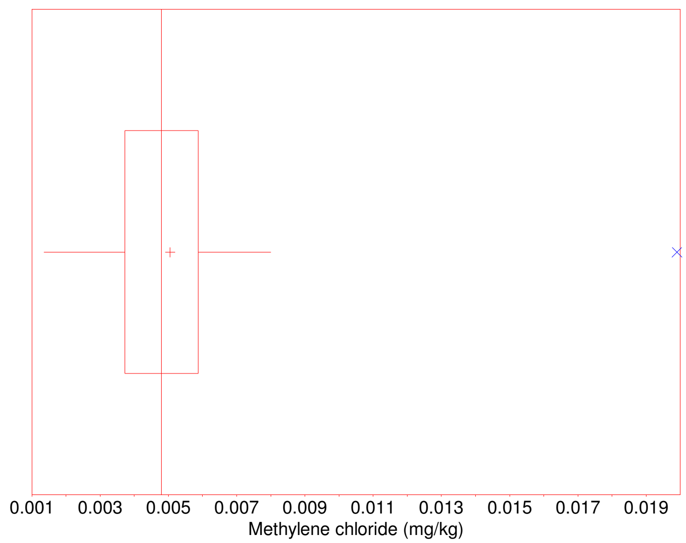
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over

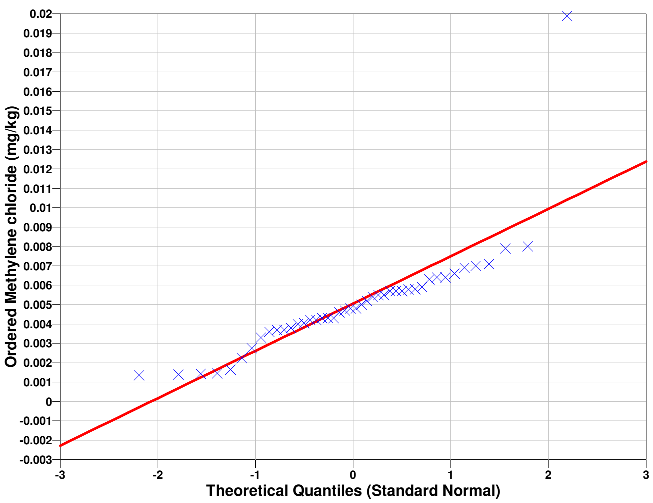
their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Methylene chloride

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution.

The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7343
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.00578
95% Non-Parametric (Chebyshev) UCL	0.006938

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.006938) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (150),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-8821.1	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Nickel
The following data points were entered by the user for analysis.

Nickel (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.31	0.47	0.515	0.67	0.72	0.83	0.88	1.1	1.1	1.1
10	1.2	1.3	1.3	1.3	1.35	1.4	1.4	1.4	1.5	1.6
20	1.7	1.8	2.05	2.1	2.1	2.1	2.4	2.45	2.7	2.7
30	2.9	3.1	4.4	4.9	5.4	7.2	8	8.6	8.74	9.4
40	11.4	12.7	18.1	23.5						

SUMMARY STATISTICS for Nickel	
n	44
Min	0.31
Max	23.5
Range	23.19
Mean	3.9065
Median	1.925
Variance	23.728
StdDev	4.8712
Std Error	0.73436
Skewness	2.4111
Interquartile Range	3.55

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.31	0.4812	0.695	1.225	1.925	4.775	10.4	16.75	23.5

Outlier Test

Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Nickel			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.022	3.08	Yes

The test statistic 4.022 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Nickel	
1	23.5

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is

recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7223
Shapiro-Wilk 5% Critical Value	0.943

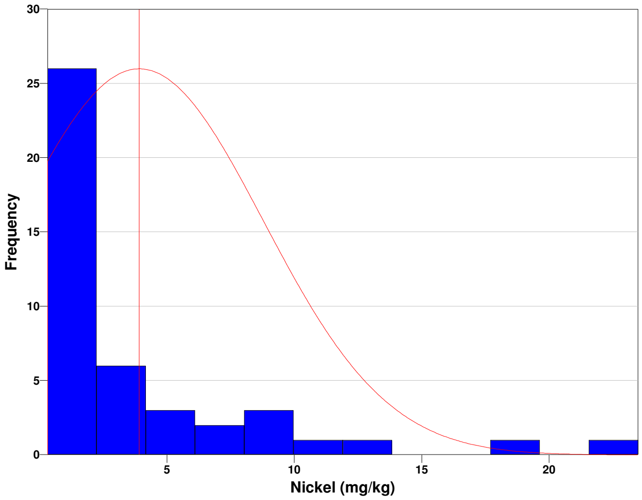
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

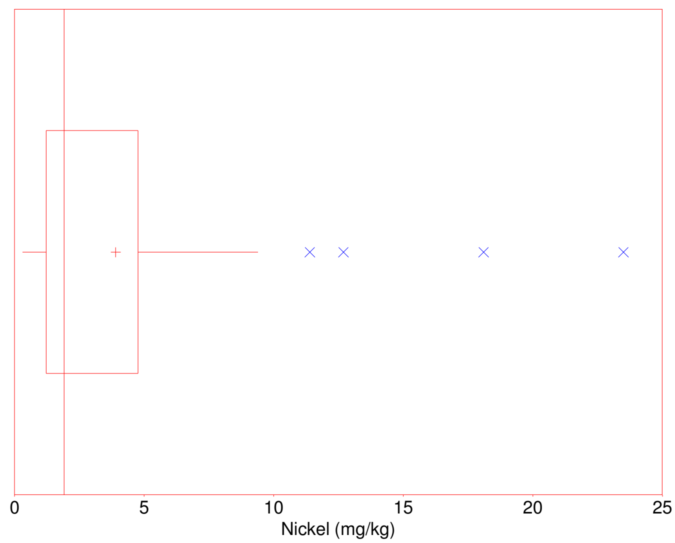
Data Plots for Nickel
Graphical displays of the data are shown below.

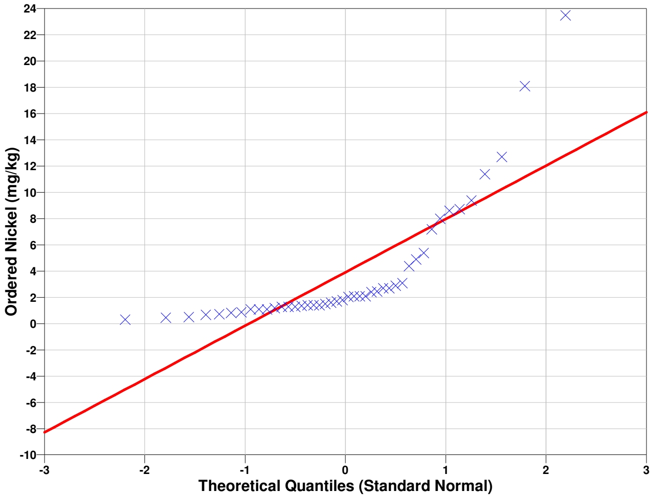
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Nickel
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6815
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	5.141
95% Non-Parametric (Chebyshev) UCL	7.107

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (7.107) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (150),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-23.141	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
43	27	Reject

Data Analysis for Silver
The following data points were entered by the user for analysis.

Silver (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.038	0.041	0.041	0.0415	0.0415	0.042	0.042	0.042	0.0423	0.043
10	0.0435	0.0435	0.044	0.044	0.045	0.045	0.0455	0.0458	0.046	0.046
20	0.0465	0.047	0.0485	0.0485	0.049	0.0495	0.05	0.05	0.055	0.07
30	0.089	0.09	0.093	0.095	0.11	0.12	0.15	0.175	0.24	0.24
40	0.27	0.32	1.1	1.3						

SUMMARY STATISTICS for Silver	
n	44
Min	0.038
Max	1.3
Range	1.262
Mean	0.1311
Median	0.04775
Variance	0.060736
StdDev	0.24645
Std Error	0.037153
Skewness	4.0686
Interquartile Range	0.051

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.038	0.041	0.0415	0.0435	0.04775	0.0945	0.255	0.905	1.3

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Silver			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.743	3.08	Yes

The test statistic 4.743 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Silver	
1	1.3

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.4055
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

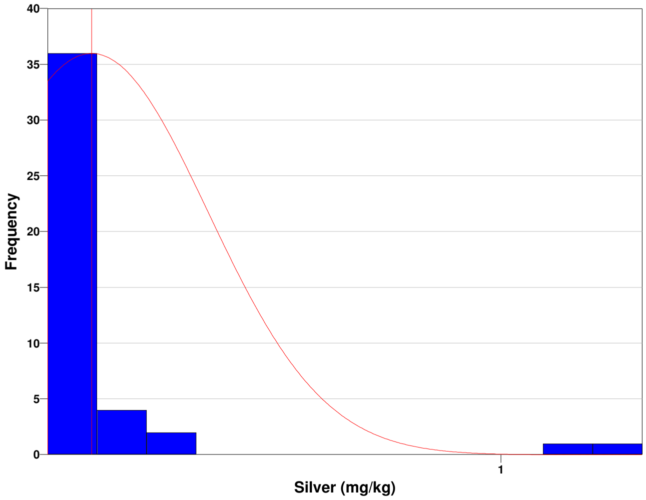
Data Plots for Silver
Graphical displays of the data are shown below.

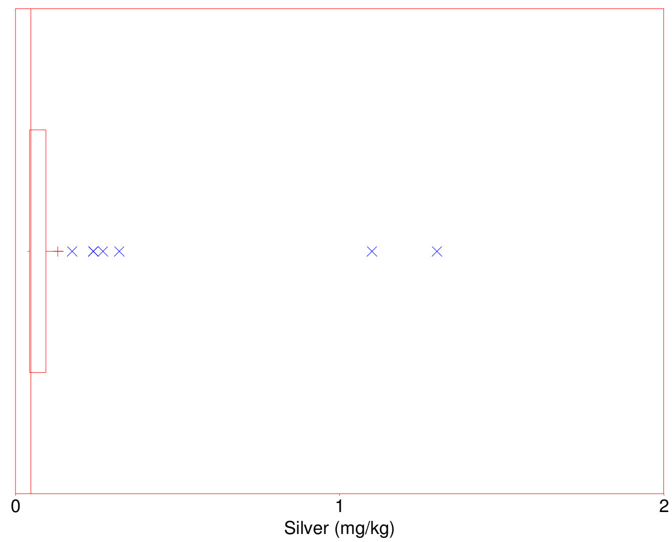
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

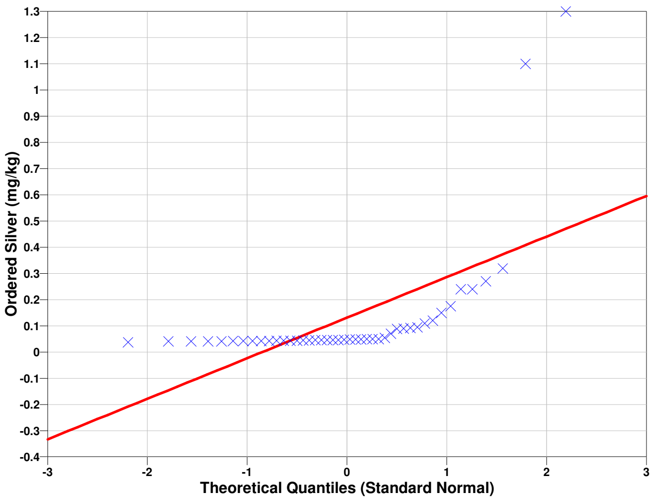
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the

Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Silver

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.4041
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.1936
95% Non-Parametric (Chebyshev) UCL	0.2931

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.2931) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (150),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-23.387	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
42	27	Reject

Data Analysis for Toluene
The following data points were entered by the user for analysis.

Toluene (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00065	0.00065	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007
10	0.000725	0.000725	0.000725	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075
20	0.00075	0.00075	0.00075	0.0008	0.0008	0.0008	0.000825	0.0009	0.0009	0.00095
30	0.001	0.00105	0.00105	0.0011	0.00115	0.0012	0.00145	0.0022	0.0027	0.0031
40	0.00315	0.00415	0.005	0.0376						

SUMMARY STATISTICS for Toluene	
n	44

Min				0.00065				
Max				0.0376				
Range				0.03695				
Mean				0.0020102				
Median				0.00075				
Variance				3.1075e-005				
StdDev				0.0055745				
Std Error				0.00084038				
Skewness				6.3366				
Interquartile Range				0.0003625				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00065	0.0006625	0.0007	0.000725	0.00075	0.001087	0.003125	0.004788	0.0376

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Toluene			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	6.384	3.08	Yes

The test statistic 6.384 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Toluene	
1	0.0376

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5618
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

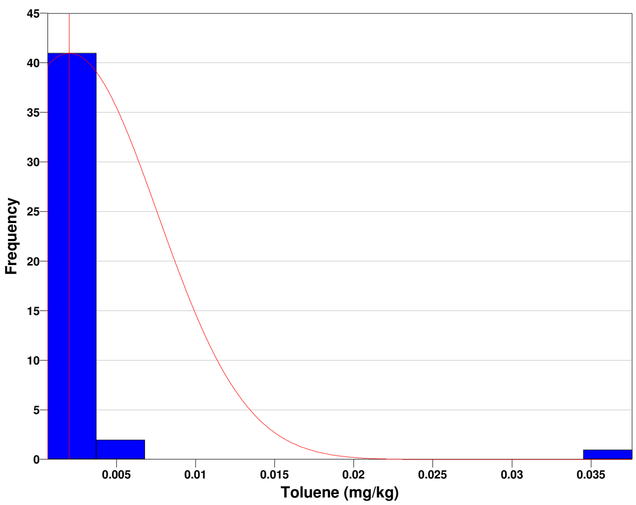
Data Plots for Toluene

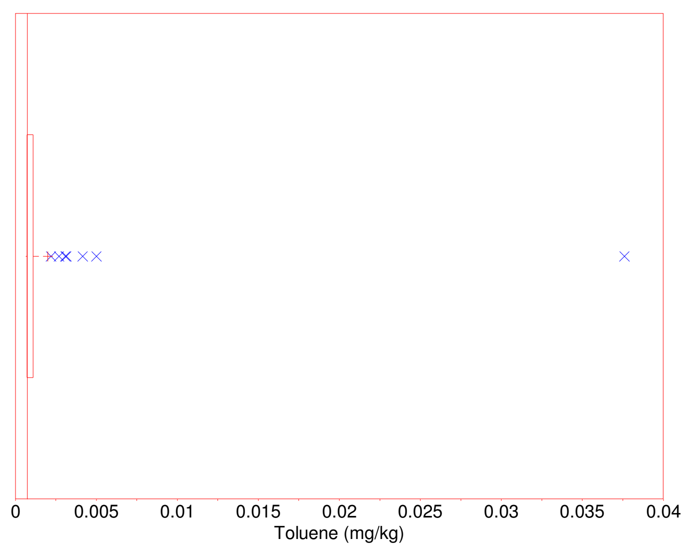
Graphical displays of the data are shown below.

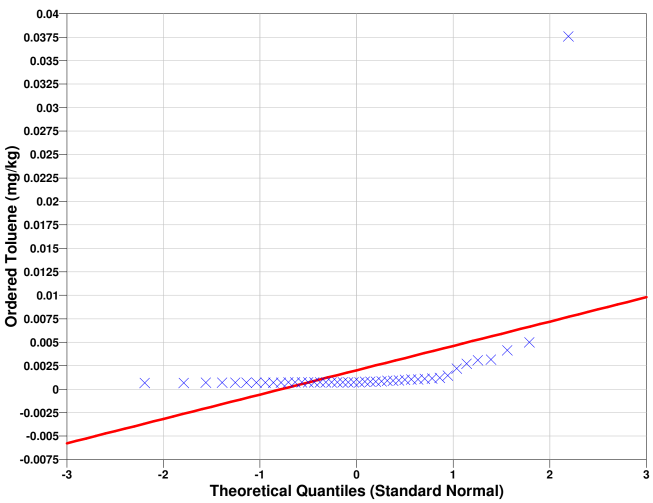
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Toluene

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.247
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.003423
95% Non-Parametric (Chebyshev) UCL	0.005673

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.005673) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test

A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where

x is the sample mean of the n=44 data,

AL is the action level or threshold (150),

SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1116.1	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**

44	27	Reject

Data Analysis for Zinc
The following data points were entered by the user for analysis.

Zinc (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	11.2	16.9	17.2	24.7	26.7	27	27.5	29.6	32.3	34.5
10	37.8	37.8	40	42.5	52.3	53.4	58.3	59.8	64.1	68.2
20	86.4	88.2	91.2	91.4	92.6	95.9	96	96.5	104	119
30	122	128	134	187	207	208	258	305	463	569
40	611	802	812	896						

SUMMARY STATISTICS for Zinc								
n	44							
Min	11.2							
Max	896							
Range	884.8							
Mean	168.75							
Median	89.7							
Variance	51655							
StdDev	227.28							
Std Error	34.263							
Skewness	2.1445							
Interquartile Range	135.95							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
11.2	16.97	25.7	37.8	89.7	173.8	590	809.5	896

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Zinc			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.2	3.08	Yes

The test statistic 3.2 exceeded the corresponding critical value, therefore that test is significant and we conclude that the

most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Zinc	
1	896

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6486
Shapiro-Wilk 5% Critical Value	0.943

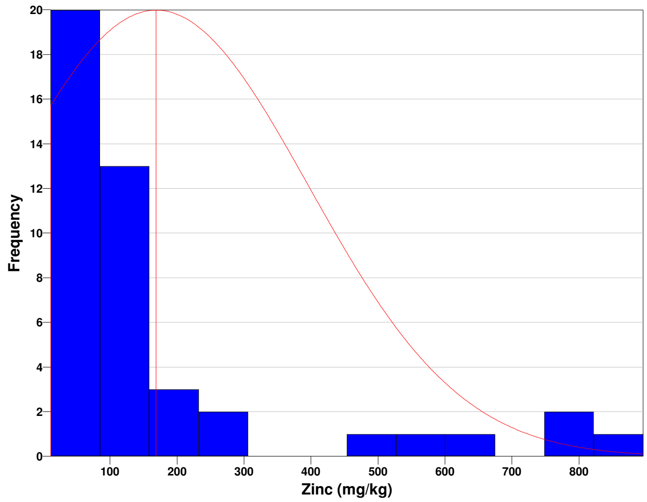
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

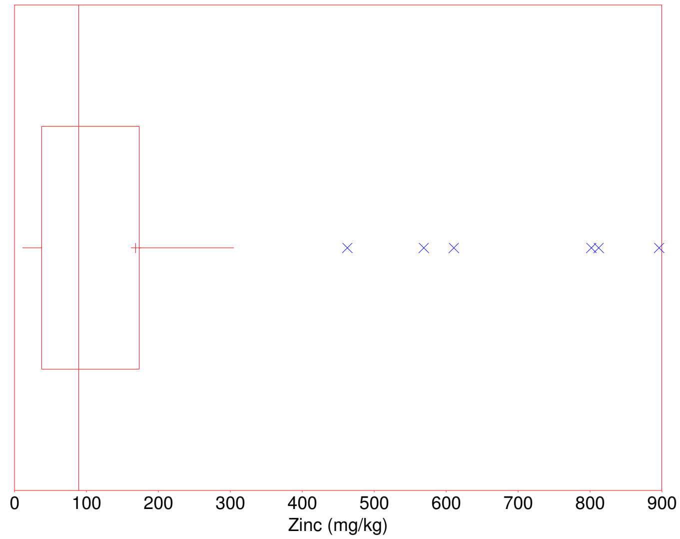
Data Plots for Zinc
Graphical displays of the data are shown below.

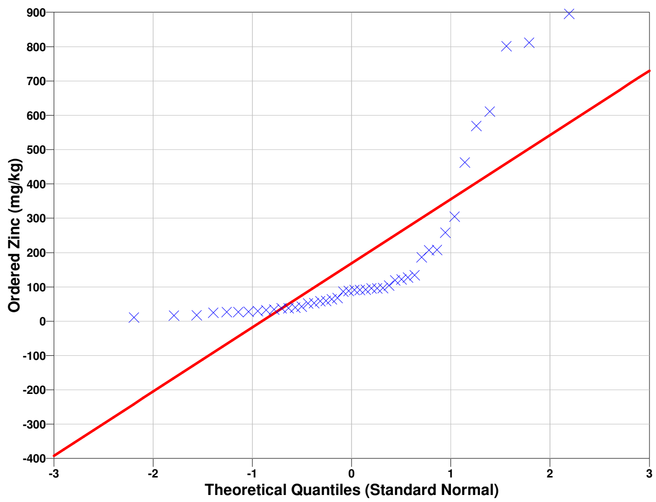
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Zinc
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6493
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	226.3

95% Non-Parametric (Chebyshev) UCL	318.1

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (318.1) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (150),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
0.54723	1.6811	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
33	27	Reject

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Software and documentation available at http://dqo.pnl.gov/vsp

* - The report contents may have been modified or reformatted by end-user of software.

Appendix C

VSP Reports of Calculated Minimum Sample Quantity
Report 26
Area of Concern – 3
Minimum Sample Quantity Calculation for Sediment using Ecological Benchmarks and Delta Method 2

Random sampling locations for comparing a mean with a fixed threshold (parametric)

Summary
This report summarizes the sampling design, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design for Zinc, the driving analyte (the analyte which required the largest number of samples). A figure that shows sampling locations in the field and a table that lists sampling location coordinates are also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean to a fixed threshold
Type of Sampling Design	Parametric
Sample Placement (Location) in the Field	Simple random sampling
Working (Null) Hypothesis	The mean value at the site exceeds the threshold
Formula for calculating number of sampling locations	Student's t-test
Calculated total number of samples	80
Number of samples on map [a]	80
Number of selected sample areas [b]	1
Specified sampling area [c]	602117.04 m^2
Total cost of sampling [d]	$41,000.00

[a] This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[d] Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.

Area: Area 1					
X Coord	**Y Coord**	**Label**	**Value**	**Type**	**Historical**
679638.4660	3083412.5610	G-21SD		Manual	T
679715.3150	3083530.0190	G-22SD		Manual	T
679789.8310	3083644.9360	G-23SD		Manual	T
679780.1110	3083404.0250	G-24SD		Manual	T
679854.2250	3083519.8220	G-25SD		Manual	T

679931.3970	3083636.4060	G-26SD		Manual	T
679841.7740	3083280.2350	G-33SD		Manual	T
679917.7660	3083397.4160	G-34SD		Manual	T
679994.2070	3083513.4470	G-35SD		Manual	T
679982.2770	3083273.0650	G-42SD		Manual	T
680056.9810	3083387.3300	G-43SD		Manual	T
680132.6500	3083505.4560	G-44SD		Manual	T
680046.7830	3083146.9990	G-51SD		Manual	T
680123.4320	3083263.0010	G-52SD		Manual	T
680198.0580	3083379.8150	G-53SD		Manual	T
680185.4120	3083138.8470	G-54SD		Manual	T
680260.4210	3083254.8070	G-55SD		Manual	T
680335.9700	3083372.0200	G-56SD		Manual	T
680022.0080	3083237.4720	J-44SD		Manual	T
680047.0950	3083215.9420	J-45SD		Manual	T
680108.0130	3083101.3520	J-57SD		Manual	T
679619.1240	3082932.8980	G-30SD		Manual	T
679693.4050	3083047.5490	G-31SD		Manual	T
679768.2260	3083162.7270	G-32SD		Manual	T
679756.1090	3082922.9390	G-39SD		Manual	T
679832.1580	3083041.8710	G-40SD		Manual	T
679906.4210	3083156.7540	G-41SD		Manual	T
679822.0740	3082799.5750	G-48SD		Manual	T
679896.6120	3082915.6660	G-49SD		Manual	T
679971.2150	3083030.7920	G-50SD		Manual	T
679887.4330	3082812.9360	J-46SD		Manual	T
679763.3990	3083050.0550	J-56SD		Manual	T
679393.4380	3082582.9470	G-27SD		Manual	T
679470.2860	3082698.0210	G-28SD		Manual	T
679543.3140	3082816.1060	G-29SD		Manual	T
679530.9430	3082575.4480	G-36SD		Manual	T
679606.6840	3082692.3830	G-37SD		Manual	T
679681.4650	3082807.7990	G-38SD		Manual	T
679597.1880	3082450.9230	G-45SD		Manual	T
679671.3170	3082565.9250	G-46SD		Manual	T
679745.9820	3082681.3860	G-47SD		Manual	T
679521.7790	3082672.0220	J-54SD		Manual	T
679590.0920	3082773.1840	J-55SD		Manual	T
679643.7788	3083158.3255	J-58SD		Adaptive-Fill	
679532.3592	3083001.1627		0	Adaptive-Fill	
679672.0005	3083628.8858		0	Adaptive-Fill	

679594.8352	3083502.7010		0	Adaptive-Fill	
679715.1333	3083259.0196		0	Adaptive-Fill	
679805.7489	3083737.1826		0	Adaptive-Fill	
679462.8639	3082516.0050		0	Adaptive-Fill	
680213.3224	3083466.6329		0	Adaptive-Fill	
679583.8024	3083077.2251		0	Adaptive-Fill	
679536.1298	3083425.6991		0	Adaptive-Fill	
679931.8556	3083469.0999		0	Adaptive-Fill	
679600.6636	3082547.3760		0	Adaptive-Fill	
679829.1419	3083113.6118		0	Adaptive-Fill	
679783.6528	3083571.7670		0	Adaptive-Fill	
680116.9122	3083333.9033		0	Adaptive-Fill	
680255.9144	3083184.0479		0	Adaptive-Fill	
679739.6854	3082847.8039		0	Adaptive-Fill	
680065.7835	3083530.2934		0	Adaptive-Fill	
679754.0173	3082600.9652		0	Adaptive-Fill	
680130.2306	3083436.8047		0	Adaptive-Fill	
680190.7320	3083069.7496		0	Adaptive-Fill	
679903.7693	3083325.9360		0	Adaptive-Fill	
679987.8905	3083370.1581		0	Adaptive-Fill	
679990.6019	3083098.8273		0	Adaptive-Fill	
679966.8714	3082923.9852		0	Adaptive-Fill	
680038.9644	3083305.1544		0	Adaptive-Fill	
679901.9997	3082993.0876		0	Adaptive-Fill	
679805.5225	3082710.8141		0	Adaptive-Fill	
679898.8560	3083066.6830		0	Adaptive-Fill	
679748.5174	3082766.0011		0	Adaptive-Fill	
680202.3609	3083286.8352		0	Adaptive-Fill	
679789.5684	3083227.0339		0	Adaptive-Fill	
679739.6625	3083707.6423		0	Adaptive-Fill	
679837.6075	3082957.0634		0	Adaptive-Fill	
679668.8717	3082658.9405		0	Adaptive-Fill	
679889.3020	3083243.4723		0	Adaptive-Fill	
679833.4898	3082899.9749		0	Adaptive-Fill	

Primary Sampling Objective
The primary purpose of sampling at this site is to compare a mean value of a site with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the mean value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the mean value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative hypothesis, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach
A parametric random sampling approach was used to determine the number of samples and to specify sampling locations.

A parametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that parametric assumptions are reasonable. These assumptions will be examined in post-sampling data analysis.

Both parametric and non-parametric approaches rely on assumptions about the population. However, non-parametric approaches typically require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than the number of samples required by non-parametric approaches.

Locating the sample points randomly provides data that are separated by many distances, whereas systematic samples are all equidistant apart. Therefore, random sampling provides more information about the spatial structure of the potential contamination than systematic sampling does. As with systematic sampling, random sampling also provides information regarding the mean value, but there is the possibility that areas of the site will not be represented with the same frequency as if uniform grid sampling were performed.

Number of Total Samples: Calculation Equation and Inputs
The equation used to calculate the number of samples is based on a Student's t-test. For this site, the null hypothesis is rejected in favor of the alternative hypothesis if the sample mean is sufficiently smaller than the threshold. The number of samples to collect is calculated so that 1) there will be a high probability (1-β) of rejecting the null hypothesis if the alternative hypothesis is true and 2) a low probability (α) of rejecting the null hypothesis if the null hypothesis is true.

The formula used to calculate the number of samples is:

$$n = \frac{S^2}{\Delta^2}\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2 + 0.5Z_{1-\alpha}^2$$

where
n is the number of samples,
S is the estimated standard deviation of the measured values including analytical error,
Δ is the width of the gray region,
α is the acceptable probability of incorrectly concluding the site mean is less than the threshold,
β is the acceptable probability of incorrectly concluding the site mean exceeds the threshold,
$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is 1-α,
$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is 1-β.

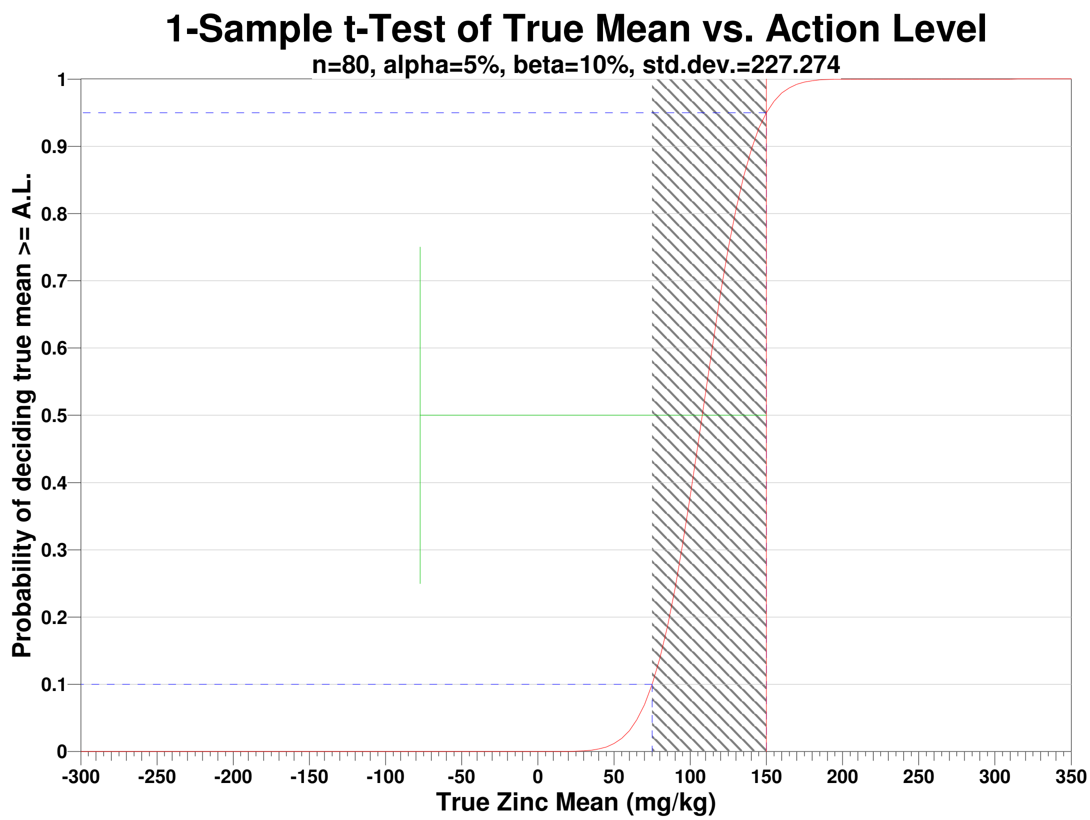
The values of these inputs that result in the calculated number of sampling locations are:

Analyte	**n**	**Parameter**					
		S	**Δ**	**α**	**β**	**$Z_{1-\alpha}$** [a]	**$Z_{1-\beta}$** [b]
New Location	2	0.1 mg/kg	10 mg/kg	0.05	0.1	1.64485	1.28155
Arsenic	6	2.98866 mg/kg	4.1 mg/kg	0.05	0.1	1.64485	1.28155
bis(2-Ethylhexyl)phthalate	20	0.132826 mg/kg	0.091 mg/kg	0.05	0.1	1.64485	1.28155
Cadmium	2	0.133983 mg/kg	0.6 mg/kg	0.05	0.1	1.64485	1.28155
Chromium	2	7.12413 mg/kg	40.5 mg/kg	0.05	0.1	1.64485	1.28155
Copper	5	10.8021 mg/kg	17 mg/kg	0.05	0.1	1.64485	1.28155
Lead	3	7.70564 mg/kg	23.35 mg/kg	0.05	0.1	1.64485	1.28155
Mercury	2	0.0182741 mg/kg	0.075 mg/kg	0.05	0.1	1.64485	1.28155
Methylene chloride	2	0.00286889 mg/kg	1.91 mg/kg	0.05	0.1	1.64485	1.28155
Nickel	4	4.87105 mg/kg	10.45 mg/kg	0.05	0.1	1.64485	1.28155
Silver	4	0.246449 mg/kg	0.5 mg/kg	0.05	0.1	1.64485	1.28155
Toluene	2	0.00557446 mg/kg	0.47 mg/kg	0.05	0.1	1.64485	1.28155
Zinc	80	227.274 mg/kg	75 mg/kg	0.05	0.1	1.64485	1.28155

[a] This value is automatically calculated by VSP based upon the user defined value of α.
[b] This value is automatically calculated by VSP based upon the user defined value of β.

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000) for Zinc, the driving analyte. It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true mean values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at 1-α on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at 1-α. If any of the inputs change, the number of samples that result in the correct curve changes.



Statistical Assumptions
The assumptions associated with the formulas for computing the number of samples are:
1. the sample mean is normally distributed (this happens if the data are roughly symmetric or the sample size is more than 30; for extremely skewed data sets, additional samples may be required for the sample mean to be normally distributed),
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected randomly.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the sample locations were selected using a random process.

Sensitivity Analysis
The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that μ > action level and alpha (%), probability of mistakenly concluding that μ < action level. The following table shows the results of this analysis.

Number of Samples

AL=150		α=5		α=10		α=15	
		s=454.548	s=227.274	s=454.548	s=227.274	s=454.548	s=227.274
LBGR=90	β=5	9940	2486	7865	1967	6603	1651
	β=10	7866	1968	6034	1509	4935	1235
	β=15	6604	1652	4935	1235	3947	987
LBGR=80	β=5	2486	623	1967	493	1651	414
	β=10	1968	493	1509	378	1235	309
	β=15	1652	414	1235	310	987	248
LBGR=70	β=5	1106	278	875	220	735	184
	β=10	876	220	672	169	549	138
	β=15	735	185	550	138	439	111

s = Standard Deviation
LBGR = Lower Bound of Gray Region (% of Action Level)
β = Beta (%), Probability of mistakenly concluding that μ > action level
α = Alpha (%), Probability of mistakenly concluding that μ < action level
AL = Action Level (Threshold)

Cost of Sampling
The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that are based on the number of samples collected and measured. Based on the numbers of samples determined above, the estimated total cost of sampling and analysis at this site is $41,000.00, which averages out to a per sample cost of $512.50. The following table summarizes the inputs and resulting cost estimates.

COST INFORMATION			
Cost Details	**Per Analysis**	**Per Sample**	**80 Samples**
Field collection costs		$100.00	$8,000.00
Analytical costs	$400.00	$400.00	$32,000.00
Sum of Field & Analytical costs		**$500.00**	**$40,000.00**
Fixed planning and validation costs			$1,000.00
Total cost			**$41,000.00**

Data Analysis for New Location
The following data points were entered by the user for analysis.

New Location (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0				

SUMMARY STATISTICS for New Location	
n	36
Min	0

Max	0
Range	0
Mean	0
Median	0
Variance	0
StdDev	0
Std Error	0
Skewness	-1.#IND
Interquartile Range	0

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0	0	0	0	0	0	0	0	0

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for New Location			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	0	-1	Yes

None of the test statistics exceeded the corresponding critical values, therefore none of the 1 tests are significant and we conclude that at the 5% significance level there are no outliers in the data.

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	1.061e+292
Shapiro-Wilk 5% Critical Value	1.376e-313

The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

Data Plots for New Location
Graphical displays of the data are shown below.

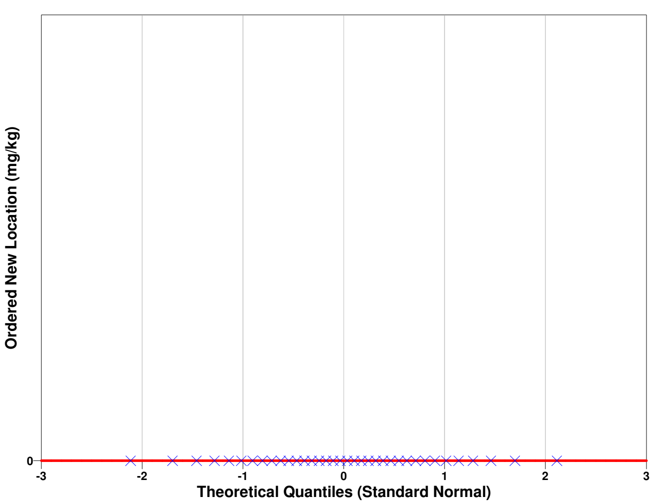
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The

sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.

New Location (mg/kg)



For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for New Location

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution.

The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0
Shapiro-Wilk 5% Critical Value	0.935

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0
95% Non-Parametric (Chebyshev) UCL	0

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=36 data,
AL is the action level or threshold (150),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=35 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1.#IND	1.6896	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
-1	-1	Reject

Data Analysis for Arsenic
The following data points were entered by the user for analysis.

Arsenic (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.31	0.33	0.43	0.45	0.455	0.625	0.67	0.74	0.75	0.75
10	0.79	0.86	0.86	1.1	1.3	1.3	1.4	1.4	1.4	1.5
20	1.5	1.5	1.6	1.6	1.6	1.7	1.7	2.13	2.2	2.3
30	2.4	2.4	2.6	2.8	2.8	3.3	4.7	4.8	5	6.3
40	6.3	6.5	8.9	17.3						

SUMMARY STATISTICS for Arsenic	
n	44
Min	0.31
Max	17.3
Range	16.99
Mean	2.5307
Median	1.55
Variance	8.9321
StdDev	2.9887
Std Error	0.45056
Skewness	3.2631
Interquartile Range	1.9425

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.31	0.355	0.4525	0.8075	1.55	2.75	6.3	8.3	17.3

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Arsenic			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.942	3.08	Yes

The test statistic 4.942 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Arsenic	
1	17.3

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is

recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.794
Shapiro-Wilk 5% Critical Value	0.943

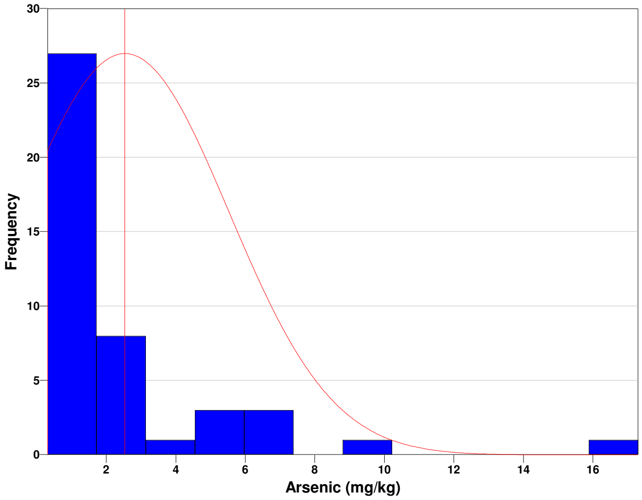
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

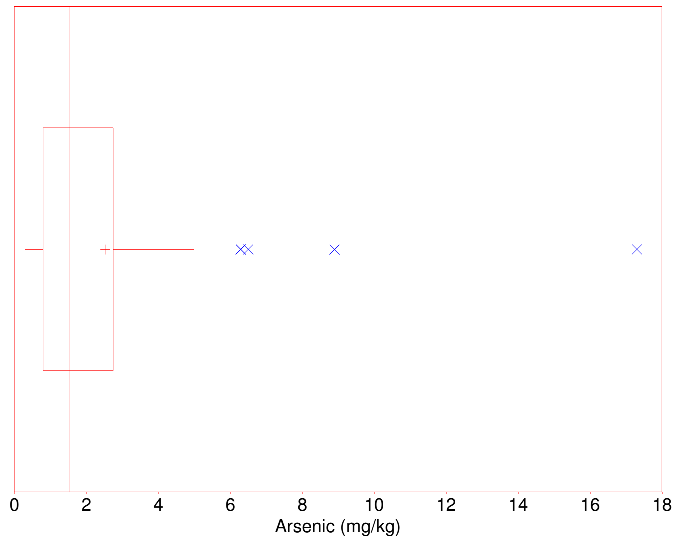
Data Plots for Arsenic
Graphical displays of the data are shown below.

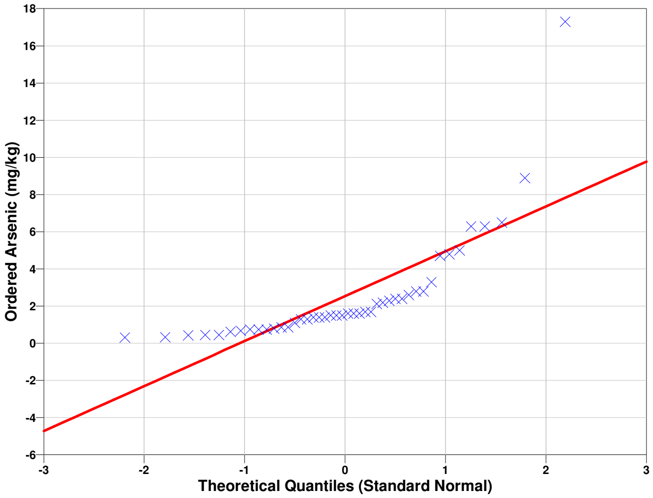
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Arsenic
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6543
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	3.288
95% Non-Parametric (Chebyshev) UCL	4.495

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (4.495) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (150),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-12.583	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
42	27	Reject

Data Analysis for bis(2-Ethylhexyl)phthalate
The following data points were entered by the user for analysis.

bis(2-Ethylhexyl)phthalate (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.046	0.0465	0.047	0.0479	0.048	0.0483	0.0485	0.0485	0.0485	0.049
10	0.0495	0.0495	0.0498	0.05	0.05	0.05	0.05	0.0525	0.055	0.055
20	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.06	0.06	0.065
30	0.065	0.065	0.065	0.075	0.085	0.095	0.1	0.136	0.153	0.215
40	0.342	0.408	0.444	0.729						

SUMMARY STATISTICS for bis(2-Ethylhexyl)phthalate								
n	44							
Min	0.046							
Max	0.729							
Range	0.683							
Mean	0.1031							
Median	0.055							
Variance	0.017642							
StdDev	0.13282							
Std Error	0.020024							
Skewness	3.3692							
Interquartile Range	0.023							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.046	0.04663	0.04795	0.0495	0.055	0.0725	0.2785	0.435	0.729

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for bis(2-Ethylhexyl)phthalate			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.712	3.08	Yes

The test statistic 4.712 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for bis(2-Ethylhexyl)phthalate	
1	0.729

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.4909
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

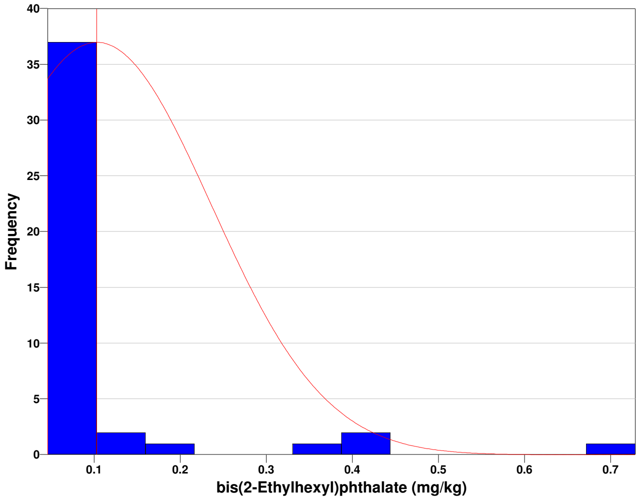
Data Plots for bis(2-Ethylhexyl)phthalate
Graphical displays of the data are shown below.

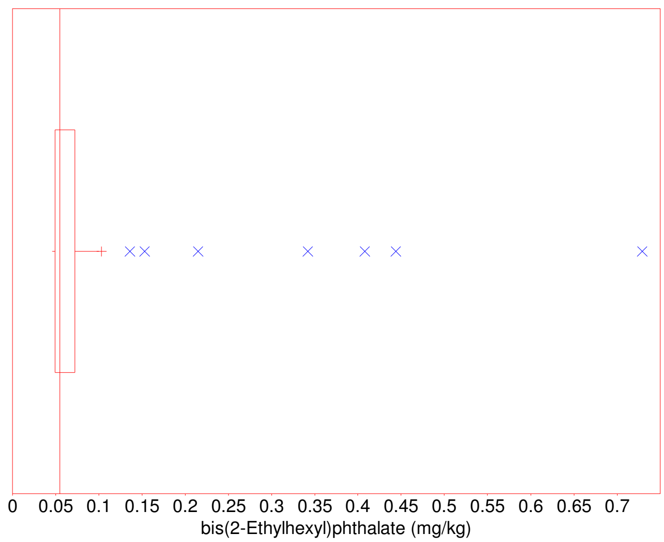
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

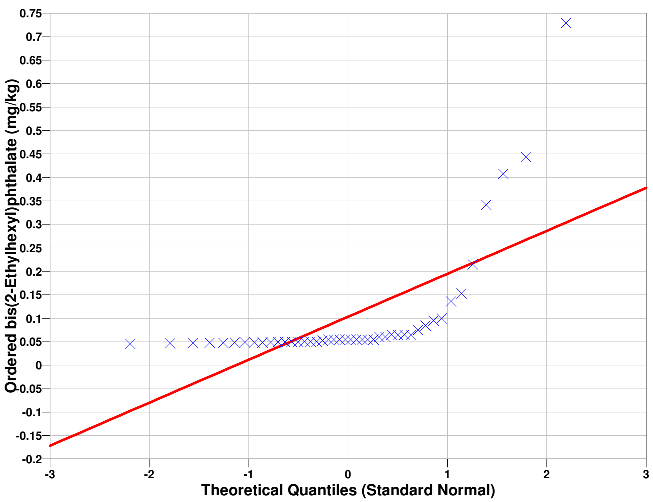
The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the

Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for bis(2-Ethylhexyl)phthalate

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.4804
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.1368
95% Non-Parametric (Chebyshev) UCL	0.1904

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.1904) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (150),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-3.9401	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
39	27	Reject

Data Analysis for Cadmium
The following data points were entered by the user for analysis.

Cadmium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.0475	0.048	0.05	0.05	0.05	0.05	0.052	0.055	0.055	0.055
10	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.0575
20	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.065	0.065	0.065
30	0.07	0.09	0.115	0.115	0.12	0.2	0.21	0.235	0.25	0.32
40	0.33	0.41	0.48	0.67						

SUMMARY STATISTICS for Cadmium	
n	44

Min				0.0475				
Max				0.67				
Range				0.6225				
Mean				0.12034				
Median				0.06				
Variance				0.017952				
StdDev				0.13398				
Std Error				0.020199				
Skewness				2.5395				
Interquartile Range				0.06				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.0475	0.0485	0.05	0.055	0.06	0.115	0.325	0.4625	0.67

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Cadmium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.102	3.08	Yes

The test statistic 4.102 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Cadmium	
1	0.67

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6044
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

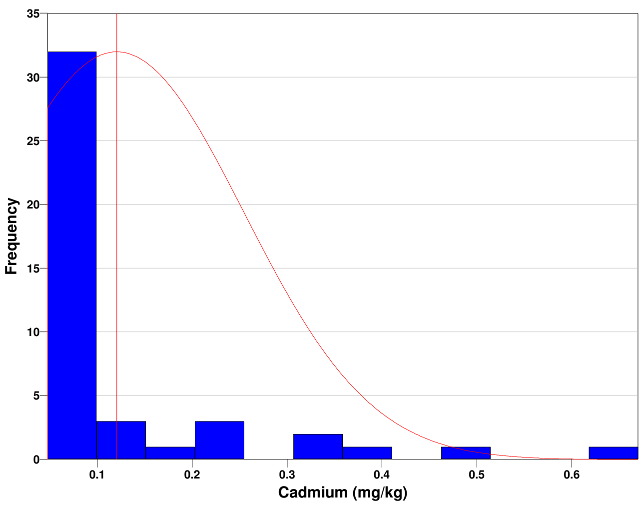
Data Plots for Cadmium

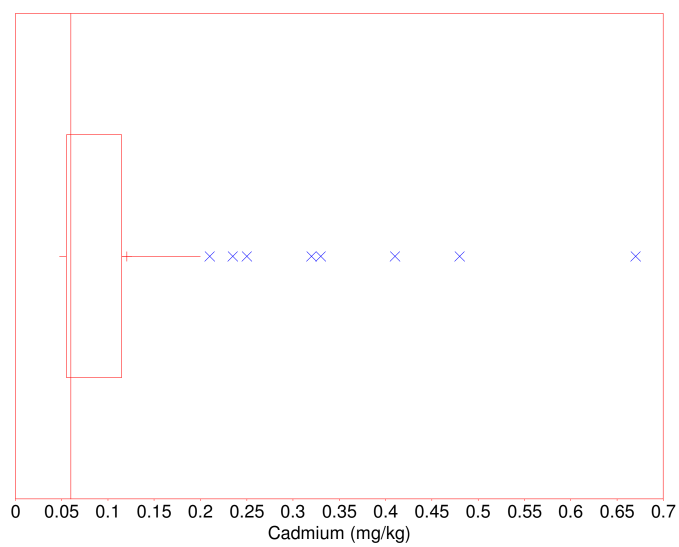
Graphical displays of the data are shown below.

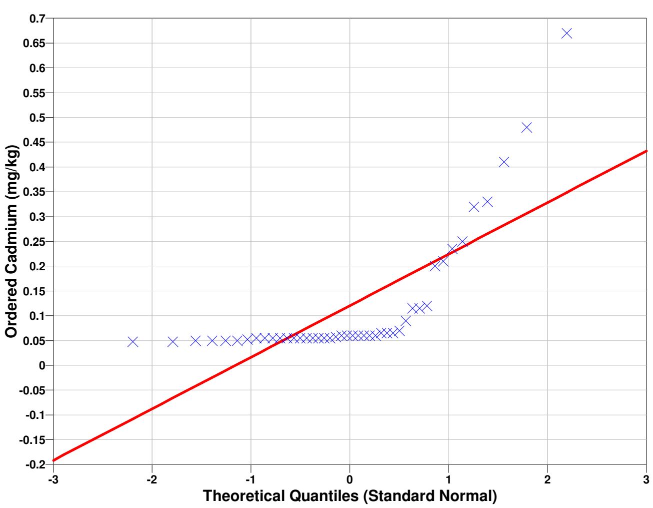
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Cadmium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.5927
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.1543
95% Non-Parametric (Chebyshev) UCL	0.2084

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.2084) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test

A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where

x is the sample mean of the n=44 data,
AL is the action level or threshold (150),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-53.452	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**

44	27	Reject

Data Analysis for Chromium
The following data points were entered by the user for analysis.

Chromium (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1.1	1.2	1.2	1.3	1.35	1.6	1.9	2	2	2.1
10	2.2	2.3	2.35	2.4	2.4	2.4	2.4	2.5	2.7	2.9
20	2.9	3.3	3.3	3.3	3.5	4.2	4.2	4.45	4.5	4.7
30	5.7	6.3	7.55	7.6	9.2	9.4	11.8	13.6	14.6	14.9
40	17.4	23.8	28.9	29.9						

SUMMARY STATISTICS for Chromium	
n	44
Min	1.1
Max	29.9
Range	28.8
Mean	6.3477
Median	3.3
Variance	50.753
StdDev	7.1241
Std Error	1.074
Skewness	2.0955
Interquartile Range	5.3625

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
1.1	1.2	1.325	2.225	3.3	7.587	16.15	27.63	29.9

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Chromium			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.306	3.08	Yes

The test statistic 3.306 exceeded the corresponding critical value, therefore that test is significant and we conclude that the

most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Chromium	
1	29.9

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7122
Shapiro-Wilk 5% Critical Value	0.943

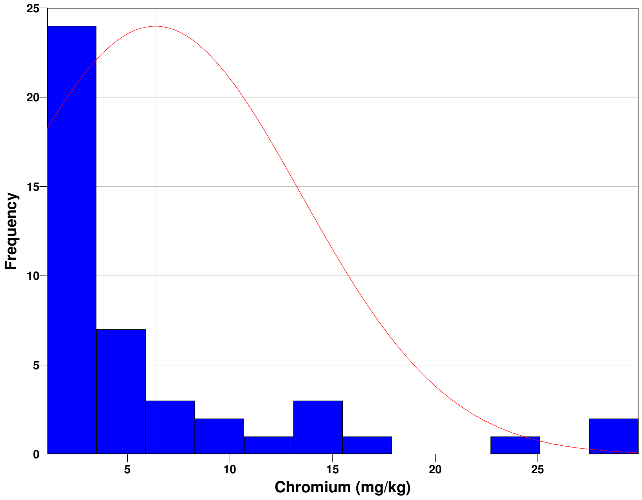
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

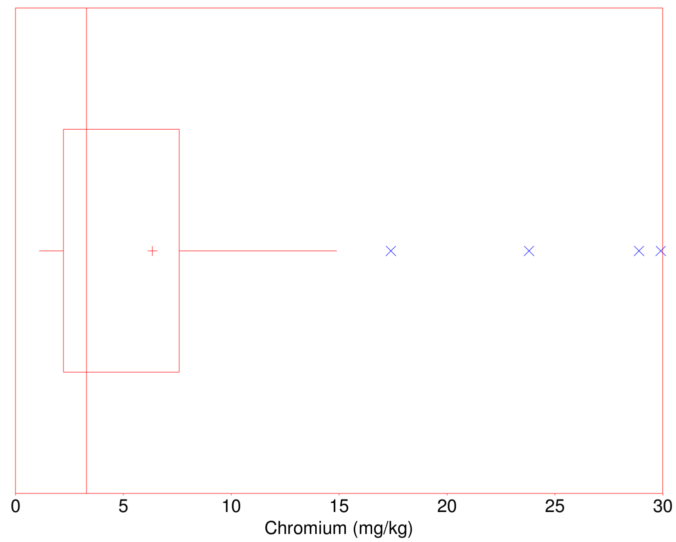
Data Plots for Chromium
Graphical displays of the data are shown below.

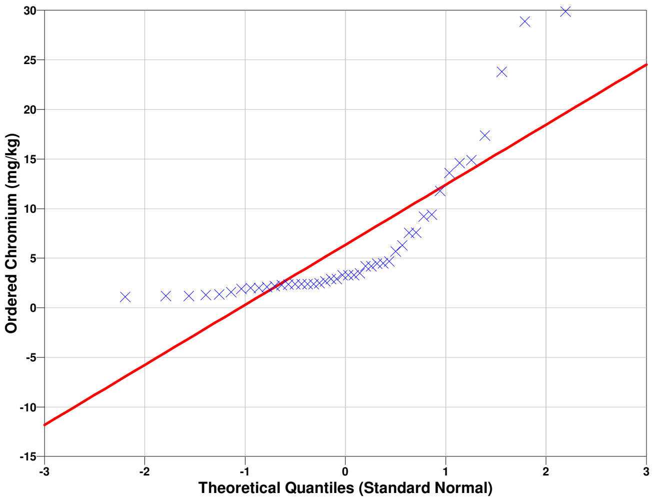
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Chromium

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6948
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	8.153

95% Non-Parametric (Chebyshev) UCL	11.03

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (11.03) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (150),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-69.508	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Copper
The following data points were entered by the user for analysis.

Copper (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1.1	1.1	1.1	1.1	1.1	1.3	1.5	1.5	1.8	1.9
10	1.9	2.1	2.1	2.2	2.5	2.5	2.5	2.6	2.8	2.8
20	2.9	2.95	3.25	3.3	3.3	3.5	3.6	4.1	4.2	4.4
30	4.6	5.3	7.1	7.7	8	12.1	15.9	19.3	20.7	21.2
40	23	24.9	32.2	57.1						

SUMMARY STATISTICS for Copper	
n	44
Min	1.1
Max	57.1

Range	56
Mean	7.5477
Median	3.1
Variance	116.7
StdDev	10.803
Std Error	1.6286
Skewness	2.8641
Interquartile Range	5.6

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
1.1	1.1	1.1	1.95	3.1	7.55	22.1	30.38	57.1

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Copper			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.587	3.08	Yes

The test statistic 4.587 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Copper	
1	57.1

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6764
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

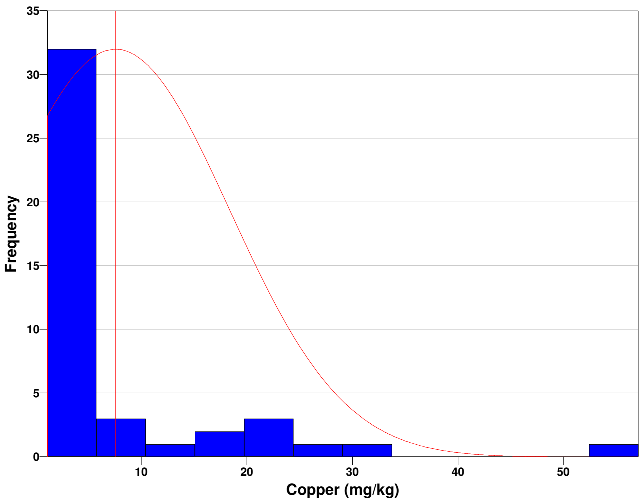
Data Plots for Copper
Graphical displays of the data are shown below.

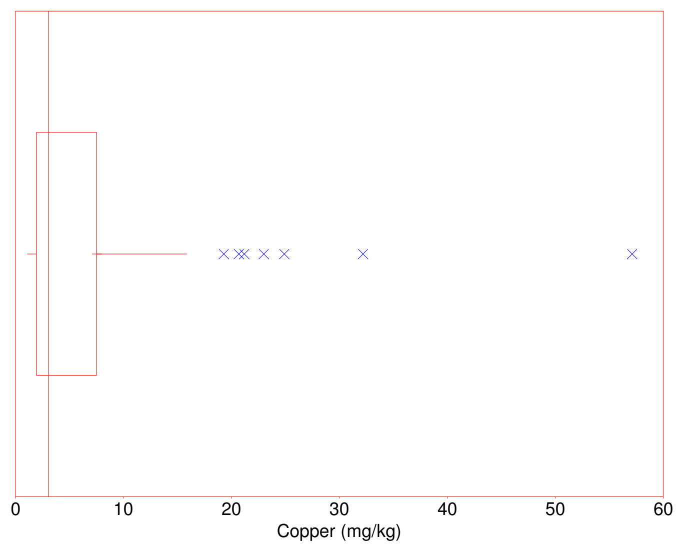
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

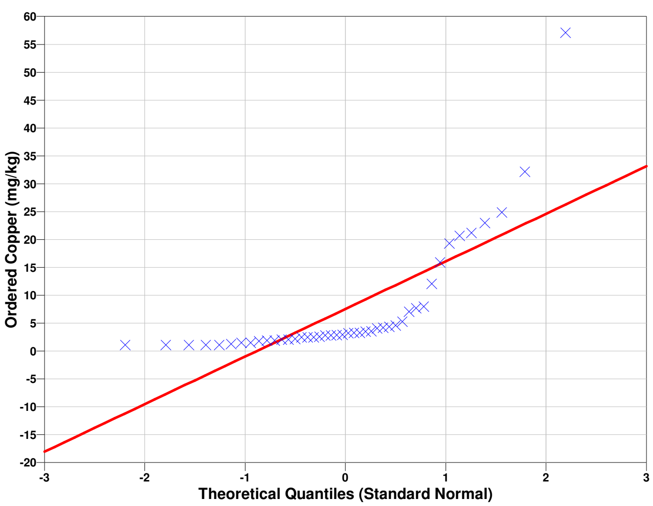
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Copper
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.62
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	10.29
95% Non-Parametric (Chebyshev) UCL	14.65

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (14.65) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (150),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-16.242	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
43	27	Reject

Data Analysis for Lead
The following data points were entered by the user for analysis.

Lead (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	1.8	2	2.1	2.3	2.4	2.5	2.5	3.1	3.1	3.1
10	3.1	3.55	3.9	4	4	4.2	4.7	4.7	4.7	4.9
20	4.9	5.2	5.4	6.2	6.55	6.7	7.5	7.65	8.1	9.1
30	9.3	9.5	10.6	11.9	12.4	13.5	14	14.1	17.9	17.9
40	18.1	29.1	30.5	34.1						

SUMMARY STATISTICS for Lead								
n	44							
Min	1.8							
Max	34.1							
Range	32.3							
Mean	8.5648							
Median	5.3							
Variance	59.377							
StdDev	7.7056							
Std Error	1.1617							
Skewness	1.8955							
Interquartile Range	8.3625							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
1.8	2.025	2.35	3.212	5.3	11.57	18	30.15	34.1

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Lead			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.314	3.08	Yes

The test statistic 3.314 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Lead

1	34.1

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7895
Shapiro-Wilk 5% Critical Value	0.943

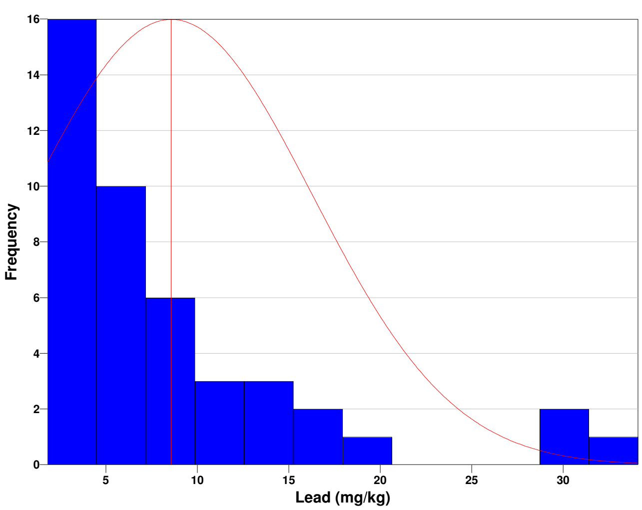
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

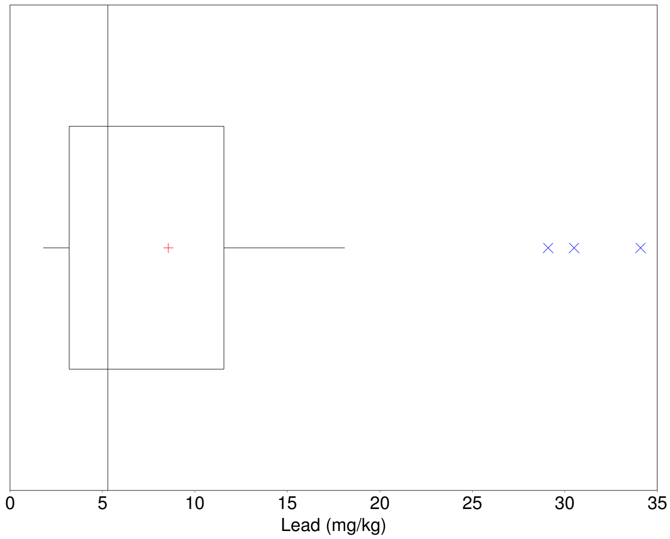
Data Plots for Lead
Graphical displays of the data are shown below.

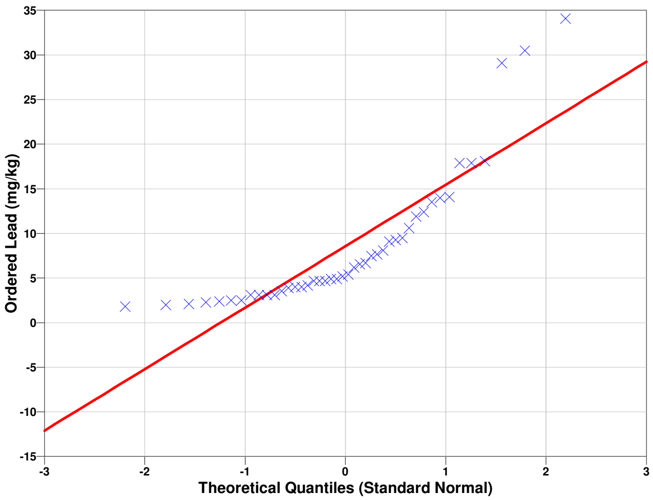
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Lead

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7669
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	10.52

95% Non-Parametric (Chebyshev) UCL	13.63

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (13.63) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (150),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-32.828	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Mercury
The following data points were entered by the user for analysis.

Mercury (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.000375	0.000385	0.00041	0.0019	0.0021	0.0029	0.00335	0.0034	0.0034	0.0037
10	0.004	0.0047	0.0051	0.0051	0.0061	0.0068	0.0071	0.0072	0.00725	0.0081
20	0.0085	0.0097	0.011	0.011	0.014	0.015	0.015	0.015	0.015	0.018
30	0.018	0.019	0.021	0.021	0.022	0.025	0.027	0.029	0.031	0.032
40	0.033	0.034	0.046	0.11						

SUMMARY STATISTICS for Mercury	
n	44
Min	0.000375
Max	0.11

Range				0.10963				
Mean				0.015536				
Median				0.01035				
Variance				0.00033394				
StdDev				0.018274				
Std Error				0.0027549				
Skewness				3.4436				
Interquartile Range				0.016825				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.000375	0.0003913	0.002	0.004175	0.01035	0.021	0.0325	0.043	0.11

Outlier Test

Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Mercury			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.169	3.08	Yes

The test statistic 5.169 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Mercury	
1	0.11

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.8976
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

Data Plots for Mercury

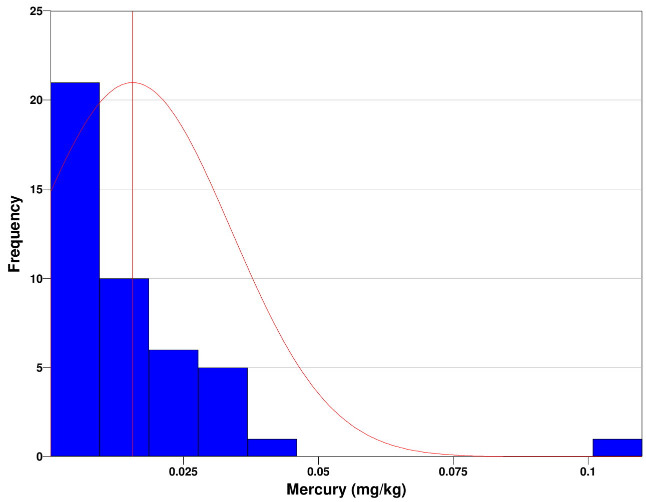
Graphical displays of the data are shown below.

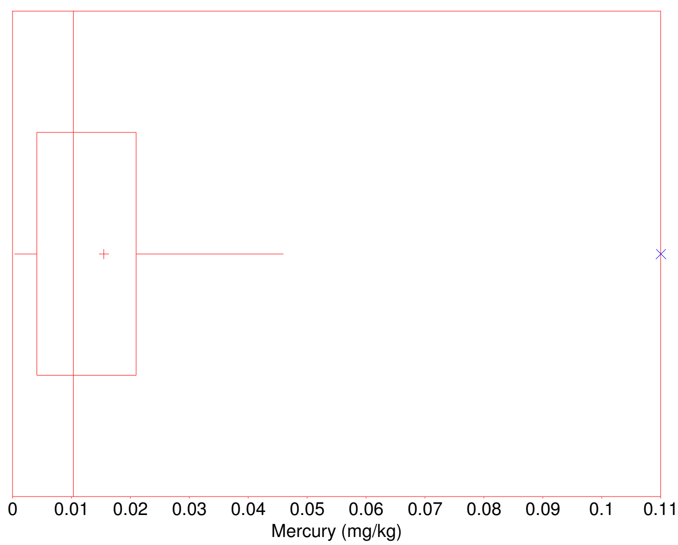
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

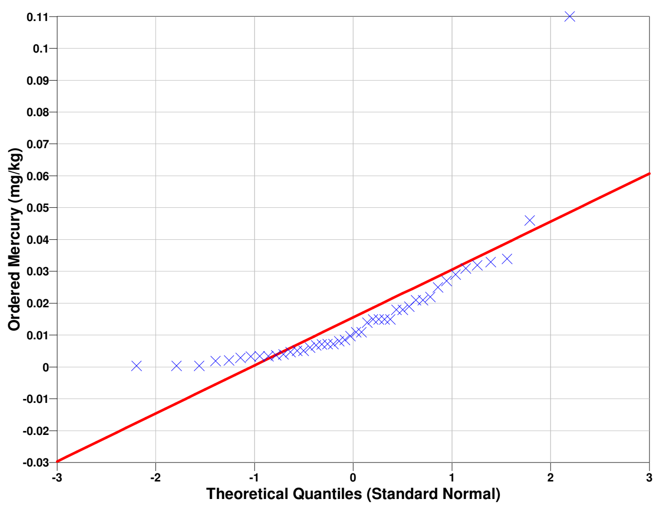
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Mercury
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6841
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.02017
95% Non-Parametric (Chebyshev) UCL	0.02754

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.02754) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (150),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-48.809	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Methylene chloride
The following data points were entered by the user for analysis.

Methylene chloride (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00135	0.0014	0.00143	0.00145	0.00165	0.00225	0.00275	0.0033	0.0036	0.0037
10	0.0037	0.0038	0.004	0.00405	0.0042	0.0042	0.0043	0.0043	0.0043	0.0046
20	0.0047	0.0048	0.0048	0.005	0.0052	0.0054	0.0055	0.0055	0.0057	0.0057
30	0.0057	0.0058	0.0058	0.0059	0.0063	0.0064	0.0064	0.0066	0.0069	0.007
40	0.0071	0.0079	0.008	0.0199						

SUMMARY STATISTICS for Methylene chloride	
n	44
Min	0.00135
Max	0.0199
Range	0.01855
Mean	0.005053
Median	0.0048
Variance	8.2297e-006
StdDev	0.0028687
Std Error	0.00043248
Skewness	3.1671
Interquartile Range	0.00215

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00135	0.001407	0.00155	0.003725	0.0048	0.005875	0.00705	0.007975	0.0199

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Methylene chloride			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	5.175	3.08	Yes

The test statistic 5.175 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Methylene chloride

1	0.0199

Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.9566
Shapiro-Wilk 5% Critical Value	0.943

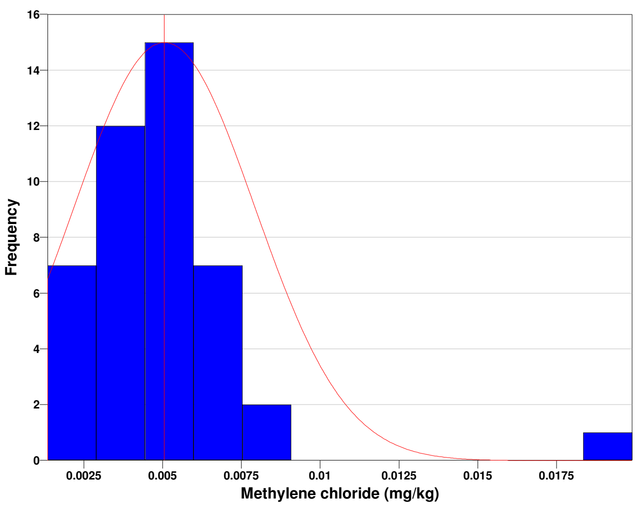
The calculated Shapiro-Wilk test statistic exceeds the 5% Shapiro-Wilk critical value, so the test cannot reject the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do appear to follow a normal distribution at the 5% level of significance.

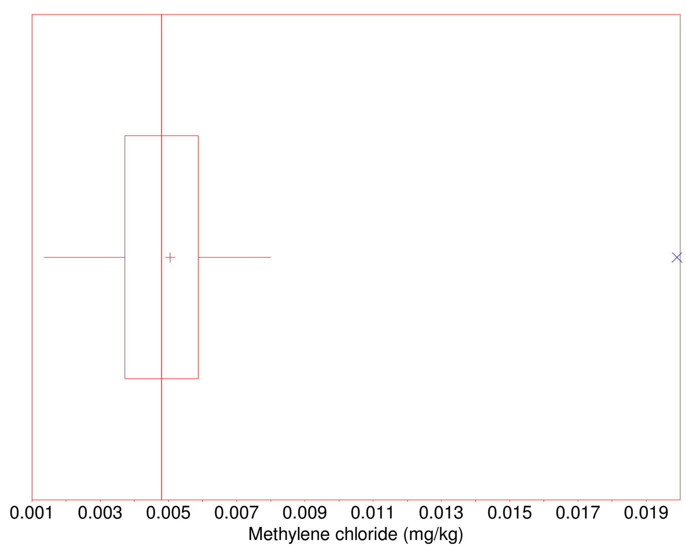
Data Plots for Methylene chloride
Graphical displays of the data are shown below.

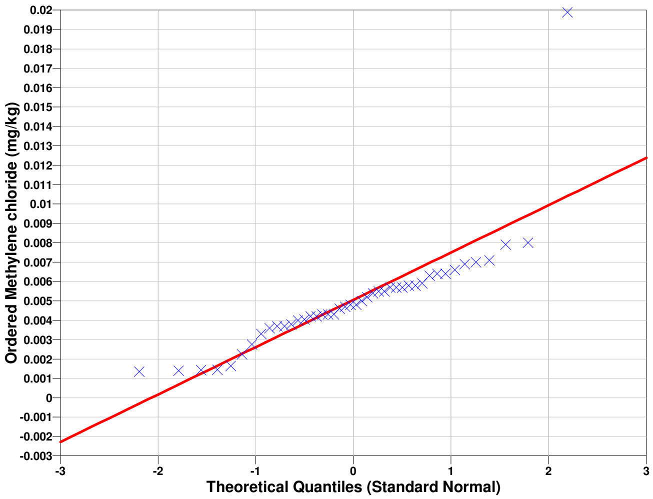
The Histogram is a plot of the fraction of the n observed data that fall within specified data "bins." A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Methylene chloride
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.7343
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.00578
95% Non-Parametric (Chebyshev) UCL	0.006938

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.006938) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (150),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-8821.1	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Nickel
The following data points were entered by the user for analysis.

Nickel (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.31	0.47	0.515	0.67	0.72	0.83	0.88	1.1	1.1	1.1
10	1.2	1.3	1.3	1.3	1.35	1.4	1.4	1.4	1.5	1.6
20	1.7	1.8	2.05	2.1	2.1	2.1	2.4	2.45	2.7	2.7
30	2.9	3.1	4.4	4.9	5.4	7.2	8	8.6	8.74	9.4
40	11.4	12.7	18.1	23.5						

SUMMARY STATISTICS for Nickel								
n	44							
Min	0.31							
Max	23.5							
Range	23.19							
Mean	3.9065							
Median	1.925							
Variance	23.728							
StdDev	4.8712							
Std Error	0.73436							
Skewness	2.4111							
Interquartile Range	3.55							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.31	0.4812	0.695	1.225	1.925	4.775	10.4	16.75	23.5

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Nickel			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.022	3.08	Yes

The test statistic 4.022 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Nickel	
1	23.5

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.7223
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

Data Plots for Nickel
Graphical displays of the data are shown below.

The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

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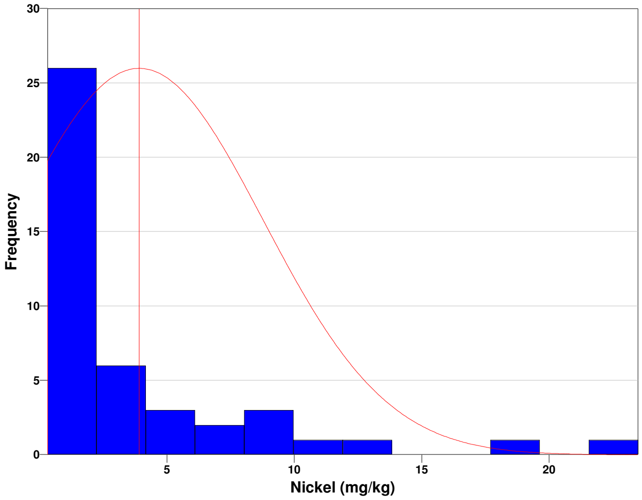
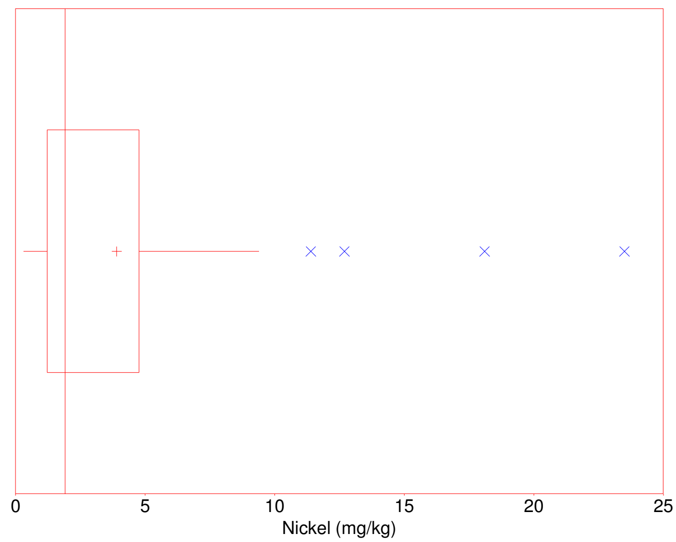
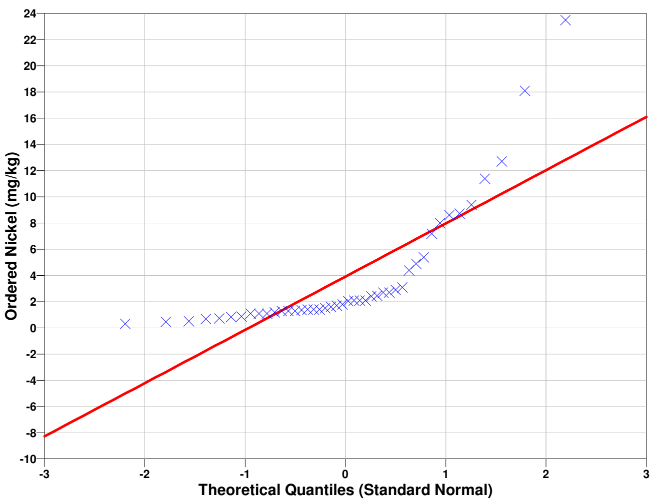
Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Nickel

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6815
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	5.141
95% Non-Parametric (Chebyshev) UCL	7.107

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (7.107) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (150),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-23.141	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
43	27	Reject

Data Analysis for Silver
The following data points were entered by the user for analysis.

Silver (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.038	0.041	0.041	0.0415	0.0415	0.042	0.042	0.042	0.0423	0.043
10	0.0435	0.0435	0.044	0.044	0.045	0.045	0.0455	0.0458	0.046	0.046
20	0.0465	0.047	0.0485	0.0485	0.049	0.0495	0.05	0.05	0.055	0.07
30	0.089	0.09	0.093	0.095	0.11	0.12	0.15	0.175	0.24	0.24
40	0.27	0.32	1.1	1.3						

SUMMARY STATISTICS for Silver	
n	44

Min	0.038
Max	1.3
Range	1.262
Mean	0.1311
Median	0.04775
Variance	0.060736
StdDev	0.24645
Std Error	0.037153
Skewness	4.0686
Interquartile Range	0.051

Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.038	0.041	0.0415	0.0435	0.04775	0.0945	0.255	0.905	1.3

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Silver			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	4.743	3.08	Yes

The test statistic 4.743 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Silver	
1	1.3

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.4055
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

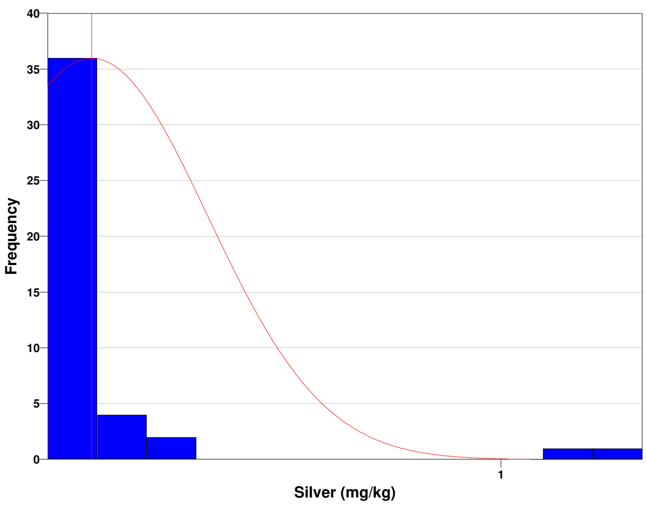
Data Plots for Silver

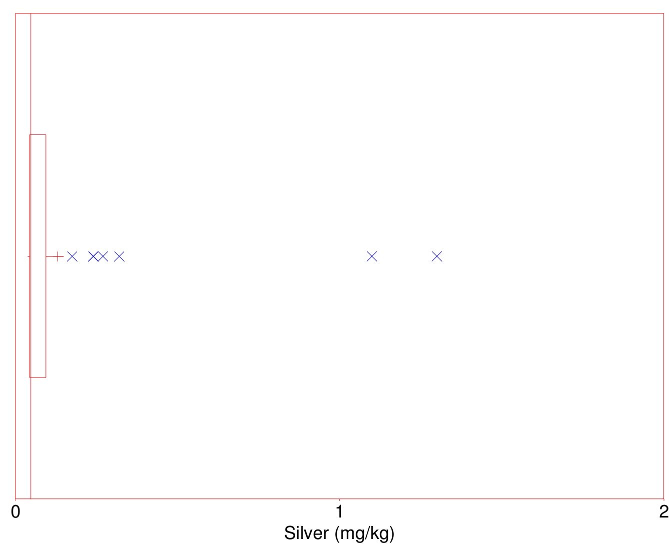
Graphical displays of the data are shown below.

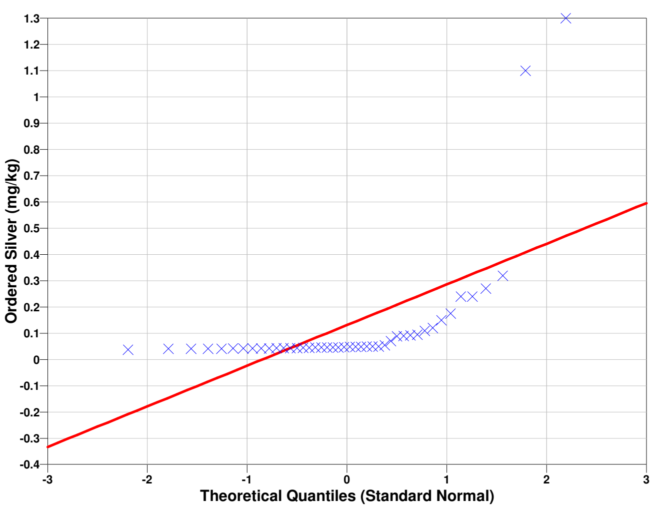
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Silver

A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.4041
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean

Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.1936
95% Non-Parametric (Chebyshev) UCL	0.2931

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.2931) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test

A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where

x is the sample mean of the n=44 data,

AL is the action level or threshold (150),

SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-23.387	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**

42	27	Reject

Data Analysis for Toluene
The following data points were entered by the user for analysis.

Toluene (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0.00065	0.00065	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007
10	0.000725	0.000725	0.000725	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075
20	0.00075	0.00075	0.00075	0.0008	0.0008	0.0008	0.000825	0.0009	0.0009	0.00095
30	0.001	0.00105	0.00105	0.0011	0.00115	0.0012	0.00145	0.0022	0.0027	0.0031
40	0.00315	0.00415	0.005	0.0376						

SUMMARY STATISTICS for Toluene								
n	44							
Min	0.00065							
Max	0.0376							
Range	0.03695							
Mean	0.0020102							
Median	0.00075							
Variance	3.1075e-005							
StdDev	0.0055745							
Std Error	0.00084038							
Skewness	6.3366							
Interquartile Range	0.0003625							
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
0.00065	0.0006625	0.0007	0.000725	0.00075	0.001087	0.003125	0.004788	0.0376

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Toluene			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	6.384	3.08	Yes

The test statistic 6.384 exceeded the corresponding critical value, therefore that test is significant and we conclude that the

most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Toluene	
1	0.0376

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.5618
Shapiro-Wilk 5% Critical Value	0.943

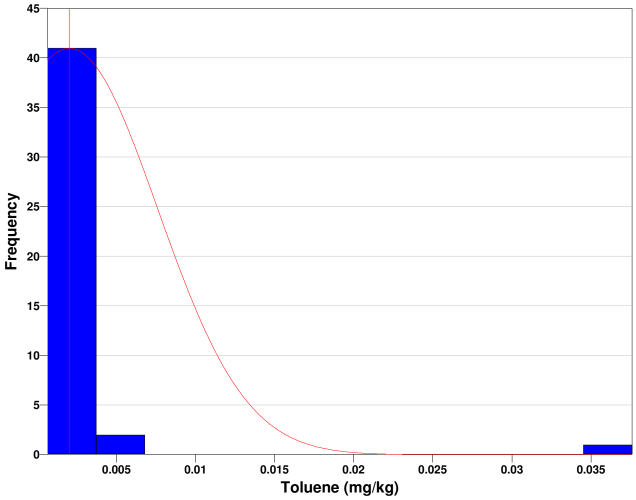
The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

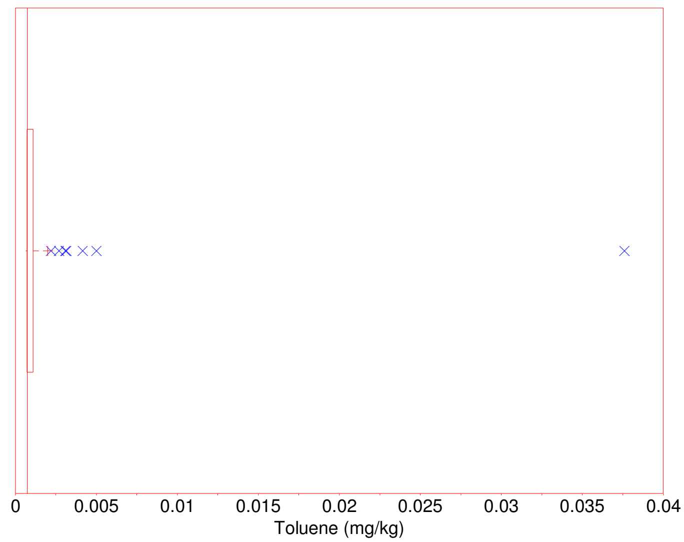
Data Plots for Toluene
Graphical displays of the data are shown below.

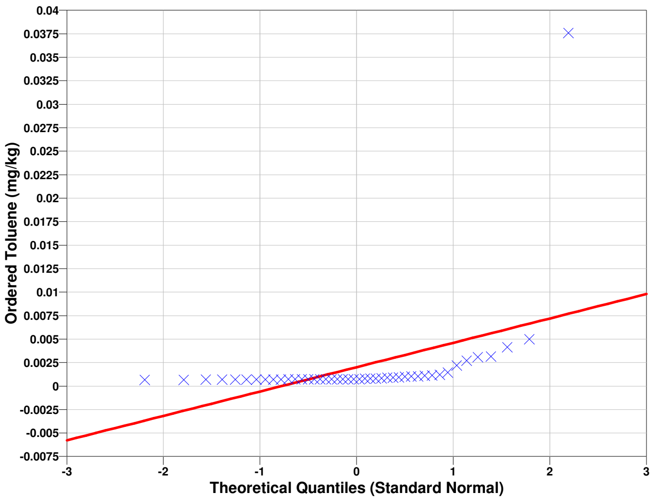
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25^{th} and 75^{th} percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The p^{th} quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Toluene
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.247
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	0.003423

95% Non-Parametric (Chebyshev) UCL	0.005673

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (0.005673) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value *t* was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (150),
SE is the standard error = (standard deviation) / (square root of n).

This *t* was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
-1116.1	1.6811	Reject

The test rejected the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean is less than the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
44	27	Reject

Data Analysis for Zinc
The following data points were entered by the user for analysis.

Zinc (mg/kg)										
Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	11.2	16.9	17.2	24.7	26.7	27	27.5	29.6	32.3	34.5
10	37.8	37.8	40	42.5	52.3	53.4	58.3	59.8	64.1	68.2
20	86.4	88.2	91.2	91.4	92.6	95.9	96	96.5	104	119
30	122	128	134	187	207	208	258	305	463	569
40	611	802	812	896						

SUMMARY STATISTICS for Zinc	
n	44
Min	11.2
Max	896

Range				884.8				
Mean				168.75				
Median				89.7				
Variance				51655				
StdDev				227.28				
Std Error				34.263				
Skewness				2.1445				
Interquartile Range				135.95				
Percentiles								
1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
11.2	16.97	25.7	37.8	89.7	173.8	590	809.5	896

Outlier Test
Rosner's test for multiple outliers was performed to test whether the most extreme value is a statistical outlier. The test was conducted at the 5% significance level.

Data should not be excluded from analysis solely on the basis of the results of this or any other statistical test. If any values are flagged as possible outliers, further investigation is recommended to determine whether there is a plausible explanation that justifies removing or replacing them.

In using Rosner's test to detect up to 1 outlier, a test statistic R_1 is calculated, and compared with a critical value C_1 to test the hypothesis that there is one outlier in the data.

ROSNER'S OUTLIER TEST for Zinc			
k	**Test Statistic R_k**	**5% Critical Value C_k**	**Significant?**
1	3.2	3.08	Yes

The test statistic 3.2 exceeded the corresponding critical value, therefore that test is significant and we conclude that the most extreme value is an outlier at the 5% significance level.

SUSPECTED OUTLIERS for Zinc	
1	896

A normal distribution test indicated that the data do not appear to be normally distributed, so further investigation is recommended before using the results of this test. Because Rosner's test can be used only when the data without the suspected outlier are approximately normally distributed, a Shapiro-Wilk test for normality was performed at a 5% significance level.

NORMAL DISTRIBUTION TEST (excluding outliers)	
Shapiro-Wilk Test Statistic	0.6486
Shapiro-Wilk 5% Critical Value	0.943

The calculated Shapiro-Wilk test statistic is less than the 5% Shapiro-Wilk critical value, so the test rejects the hypothesis that the data are normal and concludes that the data, excluding the most extreme value, do not appear to follow a normal distribution at the 5% level of significance. Rosner's test may not be appropriate if the assumption of normally distributed data is not justified for this data set. Examine the Q-Q plot displayed below to further assess the normality of the data.

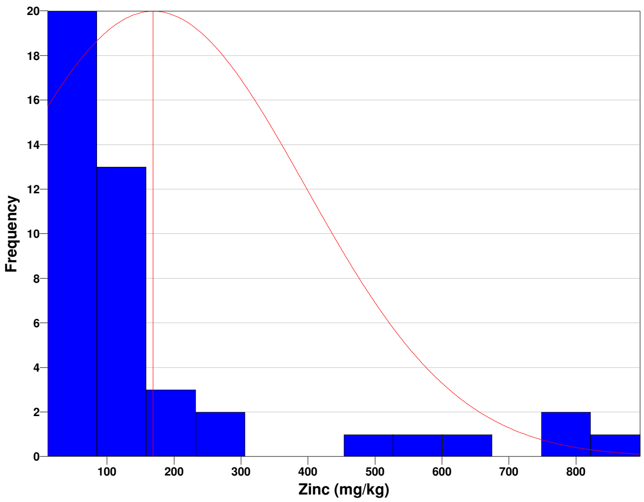
Data Plots for Zinc
Graphical displays of the data are shown below.

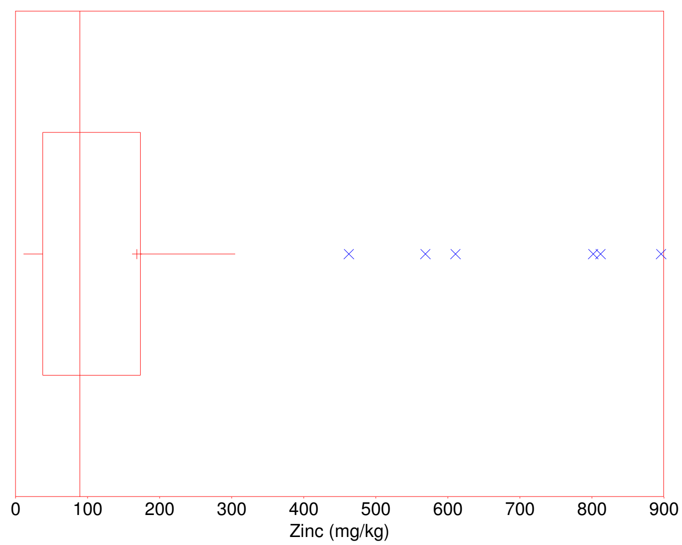
The Histogram is a plot of the fraction of the n observed data that fall within specified data “bins.” A histogram is

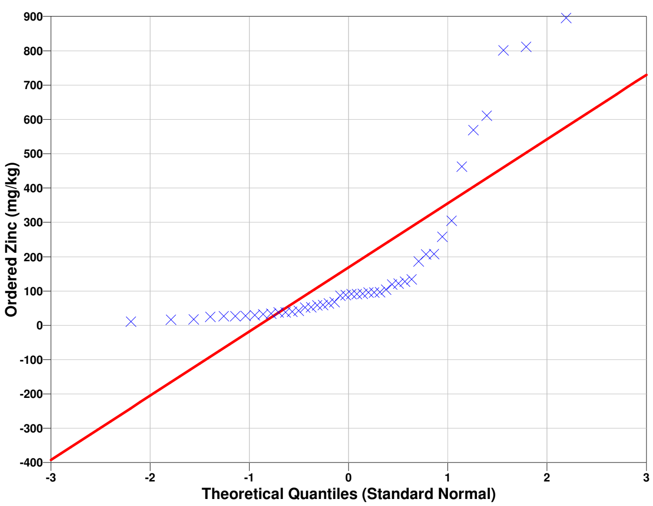
generated by dividing the x axis (range of the observed data values) into "bins" and displaying the number of data in each bin as the height of a bar for the bin. The area of the bar is the fraction of the n data values that lie within the bin. The sum of the fractions for all bins equals one. A histogram is used to assess how the n data are distributed (spread) over their range of values. If the histogram is more or less symmetric and bell shaped, then the data may be normally distributed.

The Box and Whiskers plot is composed of a central box divided by a line, and with two lines extending out from the box, called the "whiskers". The line through the box is drawn at the median of the n data observed. The two ends of the box represent the 25th and 75th percentiles of the n data values, which are also called the lower and upper quartiles, respectively, of the data set. The sample mean (mean of the n data) is shown as a "+" sign. The upper whisker extends to the largest data value that is less than the upper quartile plus 1.5 times the interquartile range (upper quartile minus the lower quartile). The lower whisker extends to the smallest data value that is greater than the lower quartile minus 1.5 times the interquartile range. Extreme data values (greater or smaller than the ends of the whiskers) are plotted individually as blue Xs. A Box and Whiskers plot is used to assess the symmetry of the distribution of the data set. If the distribution is symmetrical, the box is divided into two equal halves by the median, the whiskers will be the same length, and the number of extreme data points will be distributed equally on either end of the plot.

The Q-Q plot graphs the quantiles of a set of n data against the quantiles of a specific distribution. We show here only the Q-Q plot for an assumed normal distribution. The pth quantile of a distribution of data is the data value, x_p, for which a fraction p of the distribution is less than x_p. If the data plotted on the normal distribution Q-Q plot closely follow a straight line, even at the ends of the line, then the data may be assumed to be normally distributed. If the data points deviate substantially from a linear line, then the data are not normally distributed.







For more information on these plots consult Guidance for Data Quality Assessment, EPA QA/G-9, pgs 2.3-1 through 2.3-12. (http://www.epa.gov/quality/qa-docs.html).

Tests for Zinc
A goodness-of-fit test was performed to test whether the data set had been drawn from an underlying normal distribution. The Shapiro-Wilk (SW) test was used to test the null hypothesis that the data are normally distributed. The test was conducted at the 5% significance level, i.e., the probability the test incorrectly rejects the null hypothesis was set at 0.05.

NORMAL DISTRIBUTION TEST	
Shapiro-Wilk Test Statistic	0.6493
Shapiro-Wilk 5% Critical Value	0.944

The calculated SW test statistic is less than the 5% Shapiro-Wilk critical value, so we can reject the hypothesis that the data are normal, or in other words the data do not appear to follow a normal distribution at the 5% level of significance. The Q-Q plot displayed above should be used to further assess the normality of the data.

Upper Confidence Limit on the True Mean
Two methods were used to compute the upper confidence limit (UCL) on the mean. The first is a parametric method that assumes a normal distribution. The second is the Chebyshev method, which requires no distributional assumption.

UCLs ON THE MEAN	
95% Parametric UCL	226.3
95% Non-Parametric (Chebyshev) UCL	318.1

Because the data do not appear to be normally distributed according to the goodness-of-fit test performed above, the non-parametric UCL (318.1) may be a more accurate upper confidence limit on the true mean.

One-Sample t-Test
A one-sample t-test was performed to compare the sample mean to the action level. The null hypothesis used is that the true mean equals or exceeds the action level (AL). The t-test was conducted at the 5% significance level. The sample value t was computed using the following equation:

$$t = \frac{\bar{x} - AL}{SE}$$

where
x is the sample mean of the n=44 data,
AL is the action level or threshold (150),
SE is the standard error = (standard deviation) / (square root of n).

This t was then compared with the critical value $t_{0.95}$, where $t_{0.95}$ is the value of the t distribution with n-1=43 degrees of freedom for which the proportion of the distribution to the left of $t_{0.95}$ is 0.95. The null hypothesis will be rejected if $t < -t_{0.95}$.

ONE-SAMPLE t-TEST		
t-statistic	**Critical Value $t_{0.95}$**	**Null Hypothesis**
0.54723	1.6811	Cannot Reject

The test did not reject the null hypothesis that the mean value at the site exceeds the threshold, therefore conclude the true mean exceeds the threshold.

Because the data do not appear to be normally distributed, the MARSSIM Sign Test might be preferred over the One Sample t-Test. The following table represents the results of the MARSSIM Sign Test using the current data:

MARSSIM Sign Test		
Test Statistic (S+)	**95% Critical Value**	**Null Hypothesis**
33	27	Reject

APPENDIX D

DETAILED SUMMARIES OF MINIMUM SAMPLE SIZE EQUATIONS

Table D-1
Calculated Minimum Sample Number to Estimate Exposure Point Concentrations for Human Health Risk Evaluation

Constituent	Quantity of Phase I samples	Concentration (mg/kg)					Sample Size Method 1	Sample Size Method 2	Statistical Power? [3]	Proposed quanity of additional samples to collect[4]	Notes
		Bench-mark	Max	Mean	95th UCL of Mean	St Dev	VSP calculated quantity of samples: Δ=sample mean-benchmark [1]	VSP calculated quantity of samples: Δ = 50% of benchmark [2]			
AOC-1: Surface Soil											
1,2,4-Trimethylbenzene	41	52.14501	0.0032	9.38E-04	9.38E-04	0.001	2	2	yes	None	
Acetone	41	5417.411	0.0963	8.19E-03	8.19E-03	0.015	2	2	yes	None	
Aluminum	41	6521.159	25400	5.73E+03	5.73E+03	5176.137	365	23	no	None	
Arsenic	41	0.389624	3.1	1.25E+00	1.25E+00	0.899	11	184	no	None	
Barium	41	7840.507	1250	1.28E+02	1.28E+02	234.679	2	2	yes	None	
Benzo(a)anthracene	41	0.147619	3.97	2.45E-01	2.45E-01	0.686	429	741	no	14	1
Benzo(a)pyrene	41	0.014762	0.775	1.12E-01	1.12E-01	0.180	31	5087	yes	None	
Benzo(b)fluoranthene	41	0.147619	1.03	0.13481707	1.35E-01	0.200	2088	65	no	14	1
Beryllium	41	37.56447	0.89	1.98E-01	1.98E-01	0.180	2	2	yes	None	
bis(2-Ethylhexyl)phthalate	39	34.74147	0.55	1.43E-01	1.43E-01	0.171	2	2	yes	None	
Cadmium	41	38.98499	1.1	1.06E-01	1.06E-01	0.181	2	2	yes	None	
Chromium	41	210.6754	14.9	4.98E+00	4.98E+00	3.527	2	2	yes	None	
Chromium - Hexavalent	41	30.09649	3.1	7.99E-01	7.99E-01	0.499	2	2	yes	None	
Chrysene	41	14.76187	41.2	1.33E+00	1.33E+00	6.554	4	9	yes	None	
Cobalt	41	902.8947	4.6	1.29E+00	1.29E+00	0.999	2	2	yes	None	
Copper	41	547.5959	23.5	4.11E+00	4.11E+00	4.008	2	2	yes	None	
Isopropylbenzene	41	370.8389	0.02265	1.57E-03	1.57E-03	0.004	2	2	yes	None	
Lead	41	400	80.7	1.43E+01	1.43E+01	17.890	2	2	yes	None	
Manganese	41	3239.292	210	7.85E+01	7.85E+01	55.777	2	2	yes	None	
Mercury	41	2.087229	0.74	3.15E-02	3.15E-02	0.114	2	2	yes	None	
Methylene chloride	41	1.261141	0.0235	4.31E-03	4.31E-03	0.005	2	2	yes	None	
Nickel	41	832.1043	9.3	2.54E+00	2.54E+00	2.087	2	2	yes	None	
Phenanthrene	41	1705.203	2.06	1.56E-01	1.56E-01	0.341	2	2	yes	None	
Pyrene	41	1697.615	1.58	1.73E-01	1.73E-01	0.281	2	2	yes	None	
Toluene	41	521.1703	0.0044	9.74E-04	9.74E-04	0.001	2	2	yes	None	
Vanadium	41	291.0143	29.3	7.64E+00	7.64E+00	6.379	2	2	yes	None	
Xylene (total)	41	214.4803	0.0077	2.89E-03	2.89E-03	0.001	2	2	yes	None	
Zinc	41	9921.474	232	4.66E+01	4.66E+01	46.576	2	2	yes	None	
AOC-1:Surface Soil number of additional samples needed for Human Health Risk Evaluation										14	

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Constituent	Quantity of Phase I samples	Concentration (mg/kg)					Sample Size Method 1	Sample Size Method 2	Statistical Power? [3]	Proposed quanity of additional samples to collect[4]	Notes
		Bench-mark	Max	Mean	95th UCL of Mean	St Dev	VSP calculated quantity of samples: Δ=sample mean-benchmark [1]	VSP calculated quantity of samples: Δ = 50% of benchmark [2]			
AOC-1: Subsurface Soil											
1,2,4-Trimethylbenzene	41	52.14501	0.14	0.00607927	6.08E-03	0.024723	2	2	yes	None	
Acetone	41	5417.411	0.249	0.02757805	2.76E-02	0.041199	2	2	yes	None	
Aluminum	41	6521.159	13800	3553.82927	3.55E+03	3361.659	13	11	yes	None	
Arsenic	41	0.389624	2.2	0.63585366	6.36E-01	0.583684	50	79	no	9	2
Barium	41	7840.507	98.7	30.545122	3.05E+01	25.31919	2	2	yes	None	
Beryllium	41	37.56447	0.42	0.11408537	1.14E-01	0.10236	2	2	yes	None	
Carbon disulfide	41	721.2542	0.0041	0.0010061	1.01E-03	0.000686	2	2	yes	None	
Chromium	41	210.6754	15	3.08878049	3.09E+00	2.694932	2	2	yes	None	
Chromium, Hexavalent	41	30.09649	1.6	0.67682927	6.77E-01	0.24852	2	2	yes	None	
Cobalt	41	902.8947	1.9	0.55902439	5.59E-01	0.499145	2	2	yes	None	
Copper	41	547.5959	5.9	1.4845122	1.48E+00	1.26381	2	2	yes	None	
Diethyl phthalate	41	1424.363	0.31	0.04579268	4.58E-02	0.050789	2	2	yes	None	
Lead	41	400	26	3.75243902	3.75E+00	3.956007	2	2	yes	None	
Manganese	41	3239.292	241	42.8329268	4.28E+01	53.72204	2	2	yes	None	
Mercury	41	2.087229	0.59	0.02477976	2.48E-02	0.091787	2	2	yes	None	
Methylene chloride	41	1.261141	0.0999	0.00737805	7.38E-03	0.015947	2	2	yes	None	
Nickel	41	832.1043	5.9	1.3347561	1.33E+00	1.420189	2	2	yes	None	
Vanadium	41	291.0143	13.7	3.95634146	3.96E+00	3.396337	2	2	yes	None	
Xylene (total)	41	214.4803	0.0217	0.00313841	3.14E-03	0.003424	2	2	yes	None	
Zinc	41	9921.474	24.8	7.4097561	7.41E+00	5.986727	2	2	yes	None	
AOC-1:Subsurface Soil number of additional samples needed for Human Health Risk Evaluation										9	
Total AOC-1: Soil number of additional samples needed for Human Health Risk Evaluation										14	

1 - D = the difference between the sample mean and the benchmark, page 107 – 108 of Guidance on Systematic Planning Using the Data Quality Objective Process, EPA QA/G4, February 2006, http://www.epa.gov/QUALITY/qs-docs/g4-final.pdf

2 - D =50% of threshold chosen in accordance with VSP User Guide, Version 5.0, September 2007, page 3.7, "[Delta] *probabilities are 20% to 95%* [of threshold], *i.e. from beta to 1-alpha … Determining a reasonable value for the size of the gray region calls for professional judgment and cost/benefit evaluation.*"

3 - statistical power is achieved when either the null hypothesis is rejected or the sample size equation indicates a sample size less than the number of Phase I samples, in this case we are focusing on the number of samples

4 - Two methods are used to calculate sample size: Method 1 is preferred because it provides the samples needed to determine a difference between the sample mean and the threshold. Sometimes the mean is very close to the threshold and the standard deviation is large so Method 1 returns unreasonable sizes. When this occurs, Method 2 results are examined as a backup. Method 2 provides the samples needed to detect a difference within 50% of the benchmark, the VSP recommended sample size is used or professional judgement, (see notes next column), when sampling is conducted for that chemical, other analyses will be run.

Notes:

1. **Benzo(b)fluoranthene:** the sample size equation indicates 14 additional samples are recommended (65-41 historical =14). The data appear extremely skewed, with only three values detected (7.3%). **Benzo(a)anthracene**: the sample size equation indicates that a large number of samples are recommended. The data appear extremely skewed, with only five values detected (12.8%). Concentrations of benzo(a)anthracene, benzo(a)pyrene and benzo(b)fluoranthene are found in the same vicinity, as follows: J-03S, J-04S, J-09S, J-12S, and J-14S. Because the concentrations are found together, a judgement was made to collect 14 samples for benzo(a)anthracene based on the sample size needed for benzo(b)fluoranthene.

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Constituent	Quantity of Phase I samples	Concentration (mg/kg)					Sample Size Method 1	Sample Size Method 2	Statistical Power? [3]	Proposed quanity of additional samples to collect[4]	Notes
		Bench-mark	Max	Mean	95th UCL of Mean	St Dev	VSP calculated quantity of samples: Δ=sample mean-benchmark [1]	VSP calculated quantity of samples: Δ = 50% of benchmark [2]			

2. Arsenic: the sample size equation indicates nine samples are recommended (50-41=9). Arsenic is a naturally occurring metal and may not be different from background.

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Table D-2
Calculated Minimum Sample Number to Estimate Exposure Point Concentrations for Ecological Risk Evaluation

Constituent	Quantity of Phase I samples	Concentration (mg/kg)					Sample Size Method 1	Sample Size Method 2	Statistical Power? [3]	Proposed quanity of additional samples to collect[4]	Notes
		Bench-mark	Max	Mean	95th UCL of Mean	St Dev	VSP calculated quantity of samples: Δ=sample mean-benchmark [1]	VSP calculated quantity of samples: Δ = 50% of benchmark [2]			
AOC-1: Surface Soil											
Arsenic	41	18	3.1	1.25E+00	1.25E+00	0.899	2	2	yes	None	
Barium	41	330	1250	1.28E+02	1.28E+02	234.679	13	19	yes	None	
Beryllium	41	10	0.55	1.98E-01	1.98E-01	0.180	2	2	yes	None	
Chromium	41	32	3.1	4.98E+00	4.98E+00	3.527	2	2	yes	None	
Chrysene	41	0.4	14.9	1.33E+00	1.33E+00	6.554	7	2665	yes	None	
Cobalt	41	13	4.6	1.29E+00	1.29E+00	0.999	2	2	yes	None	
Copper	41	61	23.5	4.11E+00	4.11E+00	4.008	2	2	yes	None	
Lead	41	120	80.7	1.43E+01	1.43E+01	17.890	2	3	yes	None	
Manganese	41	500	210	7.85E+01	7.85E+01	55.777	2	2	yes	None	
Mercury	41	0.1	0.74	3.15E-02	3.15E-02	0.114	26	47	yes	None	
Nickel	41	30	9.3	2.54E+00	2.54E+00	2.087	2	2	yes	None	
Toluene	41	200	0.0044	9.74E-04	9.74E-04	0.001	2	2	yes	None	
Vanadium	41	2	29.3	7.64E+00	7.64E+00	6.379	350	2	yes	None	1
Zinc	41	120	232	4.66E+01	4.66E+01	46.576	5	7	yes	None	
AOC-1:Surface Soil number of additional samples needed for Human Health Risk Evaluation										0	

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Constituent	Quantity of Phase I samples	Concentration (mg/kg)					Sample Size Method 1	Sample Size Method 2	Statistical Power? [3]	Proposed quanity of additional samples to collect[4]	Notes
		Bench-mark	Max	Mean	95th UCL of Mean	St Dev	VSP calculated quantity of samples: Δ=sample mean-benchmark [1]	VSP calculated quantity of samples: Δ = 50% of benchmark [2]			
AOC-1: Subsurface Soil											
Arsenic	41	0.3896239	2.2	0.63585366	6.36E-01	0.583684	2	79	yes	None	
Barium	41	7840.5067	98.7	30.545122	3.05E+01	25.31919	2	2	yes	None	
Beryllium	41	37.564473	0.42	0.11408537	1.14E-01	0.10236	2	2	yes	None	
Chromium	41	210.67544	15	3.08878049	3.09E+00	2.694932	10	2	yes	None	
Cobalt	41	902.89474	1.9	0.55902439	5.59E-01	0.499145	2	2	yes	None	
Copper	41	547.59592	5.9	1.4845122	1.48E+00	1.26381	2	2	yes	None	
Diethyl phthalate	41	1424.3631	0.31	0.04579268	4.58E-02	0.050789	2	2	yes	None	
Lead	41	400	26	3.75243902	3.75E+00	3.956007	2	2	yes	None	
Manganese	41	3239.2924	241	42.8329268	4.28E+01	53.72204	2	2	yes	None	
Mercury	41	2.0872291	0.59	0.02477976	2.48E-02	0.091787	15	2	yes	None	
Nickel	41	832.10431	5.9	1.3347561	1.33E+00	1.420189	2	2	yes	None	
Vanadium	41	291.01435	13.7	3.95634146	3.96E+00	3.396337	28	2	yes	None	
Zinc	41	9921.4739	24.8	7.4097561	7.41E+00	5.986727	2	2	yes	None	
AOC-1:Subsurface Soil number of additional samples needed for Human Health Risk Evaluation										0	
Total AOC-1: Soil number of additional samples needed for Human Health Risk Evaluation										**0**	

1 - D = the difference between the sample mean and the benchmark, page 107 – 108 of Guidance on Systematic Planning Using the Data Quality Objective Process, EPA QA/G4, February 2006, http://www.epa.gov/QUALITY/qs-docs/g4-final.pdf

2 - D = 50% of threshold chosen in accordance with VSP User Guide, Version 5.0, September 2007, page 3.7, "[Delta] *probabilities are 20% to 95%* [of threshold]*, i.e. from beta to 1-alpha … Determining a reasonable value for the size of the gray region calls for professional judgment and cost/benefit evaluation.*"

3 - Sstatistical power is achieved when either the null hypothesis is rejected or the sample size equation indicates a sample size less than the number of Phase I samples. In this case we are focusing on the number of samples

4 - Two methods are used to calculate sample size: Method 1 is preferred because it provides the samples needed to determine a difference between the sample mean and the threshold. Sometimes the mean is very close to the threshold and the standard deviation is large so Method 1 returns unreasonable sizes. When this occurs, Method 2 results are examined as a backup. Method 2 provides the samples needed to detect a difference within 50% of the benchmark, the VSP recommended sample size is used or professional judgement, (see notes next column), when sampling is conducted for that chemical, other analyses will be run.

Notes:

1. Vanadium: the Method 1sample size equation indicates a large number of samples are recommended to detect a difference between the mean of the site and the benchmark, while Method 2 indicates that there are enough samples to detect a difference of 1/2 the benchmark. Current hypothesis tests show that the null hypothesis that the site is dirty could not be rejected (see VSP output). With a benchmark of 2 mg/kg and a max and mean of 29.3 mg/kg and 6.64 mg/kg, respectively, additional samples would not likely change the outcome. There is one statistical outlier and data are highly skewed as the median is 5.25 mg/kg, quite a bit lower than the mean. For this reason and the fact that Vanadium is a naturally occurring metal and may not be different from background, additional samples are not warranted.

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Table D-3
Calculated Minimum Sample Number to Estimate Exposure Point Concentrations for Human Health Risk Evaluation

Constituent	Quantity of Phase I samples	Concentration (mg/l)					Sample Size Method 1	Sample Size Method 2	Statistical Power? [3]	Proposed quanity of additional samples to collect[4]	Notes
		Bench- mark	Max	Mean	95th UCL of Mean	St Dev	VSP calculated quantity of samples: Δ=sample mean-benchmark [1]	VSP calculated quantity of samples: Δ = 50% of benchmark [2]			
AOC-1: Ground Water- Human Health											
1-Methylnaphthalene	20	1.7109375	0.0647	0.0053375	5.34E-03	0.014493	2	2	yes	None	
Acetone	20	5.475	0.0089	0.004945	4.95E-03	0.002266	2	2	yes	None	
Aluminum	20	2.444196429	4.28	0.503205	5.03E-01	0.976173	4	7	yes	None	
Arsenic	20	0.01	0.0437	0.0084375	8.44E-03	0.010336	377	38	no	7	1
Barium	20	2	0.557	0.1824725	1.82E-01	0.139721	2	2	yes	None	
Benzene	20	0.005	0.0145	0.00112275	1.12E-03	0.003216	8	16	yes	None	
bis(2-Ethylhexyl)phthalate	20	0.004802252	0.006625	0.00126875	1.27E-03	0.001356	3	5	yes	None	
Cyclohexane	20	12.51428571	0.0323	0.001928	1.93E-03	0.00715	2	2	yes	None	
Ethylbenzene	20	0.7	0.008	0.00106075	1.06E-03	0.001955	2	2	yes	None	
Lead	20	0.015	0.0195	0.003755	3.76E-03	0.004617	3	5	yes	None	
Manganese	20	1.148772321	4.12	0.81615	8.16E-01	0.984455	77	27	no	7	2
Naphthalene	20	0.006202941	0.163	0.0117275	1.17E-02	0.036462	375	1185	no	7	3
Nickel	20	0.488839286	0.0516	0.0052025	5.20E-03	0.011178	2	2	yes	None	
Thallium	20	0.002	0.0067	0.00340875	3.41E-03	0.001813	16	30	yes	None	
Vanadium	20	0.17109375	0.01665	0.002706	2.71E-03	0.004347	2	2	yes	None	
Zinc	20	7.332589286	0.196	0.03199	3.20E-02	0.041511	2	2	yes	None	
AOC-1:Ground water number of additional samples needed for Human Health Risk Evaluation										7	

1 - D = the difference between the sample mean and the benchmark, page 107 – 108 of Guidance on Systematic Planning Using the Data Quality Objective Process, EPA QA/G4, February 2006, http://www.epa.gov/QUALITY/qs-docs/g4-final.pdf

2 - D =50% of threshold chosen in accordance with VSP User Guide, Version 5.0, September 2007, page 3.7, "[Delta] *probabilities are 20% to 95%* [of threshold], *i.e. from beta to 1-alpha … Determining a reasonable value for the size of the gray region calls for professional judgment and cost/benefit evaluation.*"

3 - statistical power is achieved when either the null hypothesis is rejected or the sample size equation indicates a sample size less than the number of Phase I samples, in this case we are focusing on the number of samples

4 - the minimum number of samples between the two methods is used to indicate if samples are needed based on the specific chemical, the VSP recommended sample size is used or professional judgement, (see notes next column), when sampling is conducted for that chemical, other analyses will be run.

Notes:

1. Arsenic the Method 1sample size equation indicates a large number of samples are recommended to detect a difference between the mean of the site and the benchmark, while Method 2 indicates a smaller but still large number of samples to detect a difference of 1/2 the benchmark. VSP indicates that the data appear nonnormal and the nonparameteric hypothesis test rejects the null hypothesis that Arsenic is greater than the benchmark and Arsenic is a naturally occurring metal and may not be different from background. For these reasons judgement is used to propose additional samples. The additional samples proposed are 7, as indicated by VSP for Manganese.

2. Manganese: the Method 1sample size equation indicates a large number of samples are recommended to detect a difference between the mean of the site and the benchmark, while Method 2 indicates a smaller number of samples to detect a difference of 1/2 the benchmark. VSP indicates that the data appear nonnormal and the nonparameteric hypothesis test rejects the null hypothesis that Manganese is greater than the benchmark and Manganese is a naturally occurring metal and may not be different from background. For these reasons the Method 2 sample size is proposed (27-20=7).

3. Naphthalene: the Method 1 sample size equation indicates a large number of samples are recommended to detect a difference between the mean of the site and the benchmark, while Method 2 indicates a smaller but still very large number of samples to detect a difference of 1/2 the benchmark. VSP indicates that the data appear nonnormal and the nonparameteric hypothesis test rejects the null hypothesis that Naphthalene is greater than the benchmark. For these reasons judgement is used to propose additional samples. The additional samples proposed are 7, as indicated by VSP for Manganese.

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Table D-4
Calculated Minimum Sample Number to Estimate Exposure Point Concentrations for Human Health Risk Evaluation

Constituent	Quantity of Phase I samples	Concentration (mg/kg)					Sample Size Method 1	Sample Size Method 2	Statistical Power? [3]	Proposed quanity of additional samples to collect[4]	Notes
		Bench-mark	Max	Mean	95th UCL of Mean	St Dev	VSP calculated quantity of samples: Δ=sample mean-benchmark [1]	VSP calculated quantity of samples: Δ = 50% of benchmark [2]			
AOC-3: Surface Soil											
Aluminum	7	6521.159	6015	4.03E+03	4.03E+03	1307.290	4	3	yes	None	
Arsenic	7	0.389624	1307.29	1.18E+00	1.18E+00	0.594	7	82	yes	None	
Barium	7	7840.507	630	1.90E+02	1.90E+02	209.832	2	2	yes	None	
Beryllium	7	37.56447	0.24	1.79E-01	1.79E-01	0.057	2	2	yes	None	
Chromium	7	210.6754	5.9	4.04E+00	4.04E+00	1.439	2	2	yes	None	
Cobalt	7	902.8947	1.35	9.80E-01	9.80E-01	0.314	2	2	yes	None	
Copper	7	547.5959	4.6	3.56E+00	3.56E+00	0.806	2	2	yes	None	
Lead	7	400	13.5	6.67142857	6.67E+00	3.391	2	2	yes	None	
Manganese	7	3239.292	226	1.07E+02	1.07E+02	55.617	2	2	yes	None	
Mercury	7	2.087229	0.022	1.19E-02	1.19E-02	0.006	2	2	yes	None	
Nickel	7	832.1043	2.5	1.83E+00	1.83E+00	0.607	2	2	yes	None	
Vanadium	7	291.0143	8.4	5.93E+00	5.93E+00	1.761	2	2	yes	None	
Zinc	7	9921.474	346	1.18E+02	1.18E+02	135.018	2	2	yes	None	
AOC-3:Surface Soil number of additional samples needed for Human Health Risk Evaluation										0	

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Constituent	Quantity of Phase I samples	Concentration (mg/kg)					Sample Size Method 1	Sample Size Method 2	Statistical Power? [3]	Proposed quanity of additional samples to collect[4]	Notes
		Bench-mark	Max	Mean	95th UCL of Mean	St Dev	VSP calculated quantity of samples: Δ=sample mean-benchmark [1]	VSP calculated quantity of samples: Δ = 50% of benchmark [2]			
AOC-3: Subsurface Soil											
Acetone	7	5417.411	0.0804	0.02867143	2.87E-02	0.024401	2	2	yes	None	
Aluminum	7	6521.159	4600	3628.57143	3.63E+03	776.7331	2	2	yes	None	
Arsenic	7	0.389624	2.4	1.12	1.12E+00	0.640651	8	9	no	1	1
Barium	7	7840.507	209	55.1857143	5.52E+01	68.79468	2	2	yes	None	
Beryllium	7	37.56447	0.2	0.16114286	1.61E-01	0.038589	2	2	yes	None	
Chromium	7	210.6754	4	3.28571429	3.29E+00	0.649175	2	2	yes	None	
Cobalt	7	902.8947	1.1	0.84571429	8.46E-01	0.200321	2	2	yes	None	
Copper	7	547.5959	5	2.44285714	2.44E+00	1.195627	2	2	yes	None	
Lead	7	400	4.3	2.98571429	2.99E+00	0.638823	2	2	yes	None	
Manganese	7	3239.292	114	72.7571429	7.28E+01	36.21725	2	2	yes	None	
Mercury	7	2.087229	0.034	0.01367143	1.37E-02	0.013946	2	2	yes	None	
Nickel	7	832.1043	2.3	1.62857143	1.63E+00	0.402965	2	2	yes	None	
Toluene	7	521.1703	0.0018	0.00129286	1.29E-03	0.000511	2	2	yes	None	
Vanadium	7	291.0143	7.9	5.32857143	5.33E+00	1.209289	2	2	yes	None	
Zinc	7	9921.474	35.8	16.6	1.66E+01	9.15387	2	2	yes	None	
AOC-3:Subsurface Soil number of additional samples needed for Human Health Risk Evaluation										1	
Total AOC-3: Soil number of additional samples needed for Human Health Risk Evaluation										**1**	

1 - D = the difference between the sample mean and the benchmark, page 107 – 108 of Guidance on Systematic Planning Using the Data Quality Objective Process, EPA QA/G4, February 2006, http://www.epa.gov/QUALITY/qs-docs/g4-final.pdf

2 - D =50% of threshold chosen in accordance with VSP User Guide, Version 5.0, September 2007, page 3.7, "[Delta] *probabilities are 20% to 95%* [of threshold]*, i.e. from beta to 1-alpha … Determining a reasonable value for the size of the gray region calls for professional judgment and cost/benefit evaluation.*"

3 - statistical power is achieved when either the null hypothesis is rejected or the sample size equation indicates a sample size less than the number of Phase I samples, in this case we are focusing on the number of samples

4 - the minimum number of samples between the two methods is used to indicate if samples are needed based on the specific chemical, the VSP recommended sample size is used or professional judgement, (see notes next column), when sampling is conducted for that chemical, other analyses will be run.

Notes:

1. **Arsenic:** VSP recommends one additional sample to detect a difference between the mean of the site and background in the subsurface soil (8-7=1). Arsenic is a naturally occurring metal and may not be different from background.

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Table D-5
Calculated Minimum Sample Number to Estimate Exposure Point Concentrations for Ecological Risk Evaluation

Constituent	Quantity of Phase I samples	Concentration (mg/kg)					Sample Size Method 1	Sample Size Method 2	Statistical Power? [3]	Proposed quanity of additional samples to collect[4]	Notes
		Bench-mark	Max	Mean	95th UCL of Mean	St Dev	VSP calculated quantity of samples: Δ=sample mean-benchmark [1]	VSP calculated quantity of samples: Δ = 50% of benchmark [2]			
AOC-3: Surface Soil											
Arsenic	7	18	1307.29	1.18E+00	1.18E+00	0.594	2	2	yes	None	
Barium	7	330	630	1.90E+02	1.90E+02	209.832	21	16	no	14	1
Beryllium	7	10	0.24	1.79E-01	1.79E-01	0.057	2	2	yes	None	
Chromium	7	0.4	5.9	4.04E+00	4.04E+00	1.439	3	445	yes	None	
Cobalt	7	13	1.35	9.80E-01	9.80E-01	0.314	2	2	yes	None	
Copper	7	61	4.6	3.56E+00	3.56E+00	0.806	2	2	yes	None	
Lead	7	120	13.5	6.67142857	6.67E+00	3.391	2	2	yes	None	
Manganese	7	500	226	1.07E+02	1.07E+02	55.617	2	2	yes	None	
Mercury	7	0.1	0.022	1.19E-02	1.19E-02	0.006	2	2	yes	None	
Nickel	7	30	2.5	1.83E+00	1.83E+00	0.607	2	2	yes	None	
Vanadium	7	2	8.4	5.93E+00	5.93E+00	1.761	4	28	yes	None	
Zinc	7	120	346	1.18E+02	1.18E+02	135.018	34926	45	no	14	2
AOC-3:Surface Soil number of additional samples needed for Ecological Risk Evaluation										14	

APPENDIX D
VSP EVALUATION TABLES
FALCON REFINERY
INGLESIDE, TEXAS

Constituent	Quantity of Phase I samples	Concentration (mg/kg) Bench-mark	Max	Mean	95th UCL of Mean	St Dev	Sample Size Method 1 VSP calculated quantity of samples: Δ=sample mean-benchmark [1]	Sample Size Method 2 VSP calculated quantity of samples: Δ = 50% of benchmark [2]	Statistical Power? [3]	Proposed quanity of additional samples to collect[4]	Notes
AOC-3: Subsurface Soil											
Arsenic	7	18	2.4	1.12	1.12E+00	0.640651	2	2	yes	None	
Barium	7	330	209	55.1857143	5.52E+01	68.79468	2	3	yes	None	
Beryllium	7	10	0.2	0.16114286	1.61E-01	0.038589	2	2	yes	None	
Chromium	7	0.4	4	3.28571429	3.29E+00	0.649175	2	92	yes	None	
Cobalt	7	13	1.1	0.84571429	8.46E-01	0.200321	2	2	yes	None	
Copper	7	61	5	2.44285714	2.44E+00	1.195627	2	2	yes	None	
Lead	7	120	4.3	2.98571429	2.99E+00	0.638823	2	2	yes	None	
Manganese	7	500	114	72.7571429	7.28E+01	36.21725	2	2	yes	None	
Mercury	7	0.1	0.034	0.01367143	1.37E-02	0.013946	2	3	yes	None	
Nickel	7	30	2.3	1.62857143	1.63E+00	0.402965	2	2	yes	None	
Toluene	7	200	0.0018	0.00129286	1.29E-03	0.000511	2	2	yes	None	
Vanadium	7	2	7.9	5.32857143	5.33E+00	1.209289	3	14	yes	None	
Zinc	7	120	35.8	16.6	1.66E+01	9.15387	2	2	yes	None	
AOC-3:Subsurface Soil number of additional samples needed for Ecological Risk Evaluation										0	
Total AOC-3: Soil number of additional samples needed for Ecological Risk Evaluation										**14**	

1 - D = the difference between the sample mean and the benchmark, page 107 – 108 of Guidance on Systematic Planning Using the Data Quality Objective Process, EPA QA/G4, February 2006, http://www.epa.gov/QUALITY/qs-docs/g4-final.pdf

2 - D =50% of threshold chosen in accordance with VSP User Guide, Version 5.0, September 2007, page 3.7, "[Delta] *probabilities are 20% to 95%* [of threshold]*, i.e. from beta to 1-alpha … Determining a reasonable value for the size of the gray region calls for professional judgment and cost/benefit evaluation.*"

3 - statistical power is achieved when either the null hypothesis is rejected or the sample size equation indicates a sample size less than the number of Phase I samples, in this case we are focusing on the number of samples

4 - the minimum number of samples between the two methods is used to indicate if samples are needed based on the specific chemical, the VSP recommended sample size is used or professional judgement, (see notes next column), when sampling is conducted for that chemical, other analyses will be run.

Notes:

1. **Barium** VSP recommends 14 additional sample to detect a difference between the mean of the site and background in the subsurface soil (21-7=14). Barium is a naturally occurring metal and may not be different from background.

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Constituent	Quantity of Phase I samples	Concentration (mg/kg)					Sample Size Method 1	Sample Size Method 2	Statistical Power? [3]	Proposed quanity of additional samples to collect[4]	Notes
		Bench-mark	Max	Mean	95th UCL of Mean	St Dev	VSP calculated quantity of samples: Δ=sample mean-benchmark [1]	VSP calculated quantity of samples: Δ = 50% of benchmark [2]			

<u>2. Zinc</u>: the Method 1sample size equation indicates a large number of samples are recommended to detect a difference between the mean of the site and the benchmark, while Method 2 indicates a smaller number of samples to detect a difference of 1/2 the benchmark. The Method 2 number still seems too high given that the current hypothesis tests show that the null hypothesis that the site is dirty could not be rejected (see VSP output), additional samples would not likely change the outcome. For this reason and the fact that Zinc is a naturally occurring metal and may not be different from background, additional samples equal to those recommended for Barium are proposed.

Table D-6
Calculated Minimum Sample Number to Estimate Exposure Point Concentrations for Human Health and Ecological Risk Evaluation

Constituent	Quantity of Phase I samples	Bench-mark	Concentration (mg/l) Max	Mean	95th UCL of Mean	St Dev	Sample Size Method 1 VSP calculated quantity of samples: Δ=sample mean-benchmark [1]	Sample Size Method 2 VSP calculated quantity of samples: Δ = 50% of benchmark [2]	Statistical Power? [3]	Proposed quanity of additional samples to collect[4]	Notes
AOC-3: Surface Water- Human Health											
Antimony	7	0.64	0.0042	0.00296071	2.96E-03	0.001245	2	2	yes	None	
Chromium - Hexavalent	7	2.216	0.016	0.00685714	6.86E-03	0.006122	2	2	yes	None	
Lead	7	0.0169	0.0102	0.00446429	4.46E-03	0.002869	2	2	yes	None	
Manganese	7	0.1	0.194	0.05854286	5.85E-02	0.078975	33	23	no	16	1
Zinc	7	26	0.0758	0.02977143	2.98E-02	0.020735	2	2	yes	None	
AOC-3:Surface water number of additional samples needed for Human Health Risk Evaluation										16	
AOC-3: Surface Water- Ecological											
Barium	7	25	0.768	0.47722857	4.77E-01	0.243435	2	2	yes	None	
Chromium - Hexavalent	7	0.0496	0.016	0.00685714	6.86E-03	0.006122	2	2	yes	None	
Lead	7	0.0053	0.0102	0.00446429	4.46E-03	0.002869	103	12	no	5	2
Zinc	7	0.0842	0.0758	0.02977143	2.98E-02	0.020735	3	4	yes	None	
AOC-3:Surface water number of additional samples needed for Ecological Risk Evaluation										5	
Total AOC-3: Surface water of additional samples needed for Human Health and Ecological Risk Evaluation										**16**	

1 - D = the difference between the sample mean and the benchmark, page 107 – 108 of Guidance on Systematic Planning Using the Data Quality Objective Process, EPA QA/G4, February 2006, http://www.epa.gov/QUALITY/qs-docs/g4-final.pdf

2 - D =50% of threshold chosen in accordance with VSP User Guide, Version 5.0, September 2007, page 3.7, "[Delta] *probabilities are 20% to 95%* [of threshold], *i.e. from beta to 1-alpha … Determining a reasonable value for the size of the gray region calls for professional judgment and cost/benefit evaluation.*"

3 - statistical power is achieved when either the null hypothesis is rejected or the sample size equation indicates a sample size less than the number of Phase I samples, in this case we are focusing on the number of samples

4 - the minimum number of samples between the two methods is used to indicate if samples are needed based on the specific chemical, the VSP recommended sample size is used or professional judgement, (see notes next column), when sampling is conducted for that chemical, other analyses will be run.

Notes:

1. Manganese: the Method 1sample size equation indicates a large number of samples are recommended to detect a difference between the mean of the site and the benchmark, while Method 2 indicates a smaller number of samples to detect a difference of 1/2 the benchmark. For this reason and the fact that Manganese is a naturally occurring metal and may not be different from background, the Method 2 sample size is proposed (23-7=16).

2. Lead: the Method 1sample size equation indicates a large number of samples are recommended to detect a difference between the mean of the site and the benchmark, while Method 2 indicates a smaller number of samples to detect a difference of 1/2 the benchmark. For this reason and the fact that Lead is a naturally occurring metal and may not be different from background, the Method 2 sample size is proposed (12-7=5).

Table D-7
Calculated Minimum Sample Number to Estimate Exposure Point Concentrations for Human Health and Ecological Risk Evaluation

Constituent	Quantity of Phase I samples	Concentration (mg/kg)					Sample Size Method 1	Sample Size Method 2	Statistical Power? [3]	Proposed quanity of additional samples to collect[4]	Notes
		Bench-mark	Max	Mean	95th UCL of Mean	St Dev	VSP calculated quantity of samples: Δ=sample mean-benchmark [1]	VSP calculated quantity of samples: Δ = 50% of benchmark [2]			
AOC-3: Sediment- Human Health											
1,2,4-Trimethylbenzene	44	37000	0.0049	0.00103239	1.03E-03	0.000903	2	2	yes	None	
Acetone	44	660000	0.668	0.05605	5.61E-02	0.107526	2	2	yes	None	
Aluminum	44	150000	35900	6668.95455	6.67E+03	8084.758	2	2	yes	None	
Arsenic	44	110	17.3	2.53068182	2.53E+00	2.988662	2	2	yes	None	
Barium	44	23000	1695	189.429545	1.89E+02	302.7682	2	2	yes	None	
Beryllium	44	27	1.4	0.27247727	2.72E-01	0.307158	2	2	yes	None	
bis(2-Ethylhexyl)phthalate	44	240	0.729	0.10309943	1.03E-01	0.132826	2	2	yes	None	
Cadmium	44	1100	0.67	0.12034091	1.20E-01	0.133983	2	2	yes	None	
Carbon disulfide	44	73000	0.0241	0.0025267	2.53E-03	0.004431	2	2	yes	None	
Chromium	44	36000	29.9	6.34772727	6.35E+00	7.124132	2	2	yes	None	
Cobalt	44	32000	10.4	1.75676136	1.76E+00	2.15433	2	2	yes	None	
Copper	44	21000	57.1	7.54659091	7.55E+00	10.80207	2	2	yes	None	
Hexane	44	44000	0.0086	0.00134716	1.35E-03	0.001539	2	2	yes	None	
Lead	44	500	34.1	8.56477273	8.56E+00	7.705635	2	2	yes	None	
Manganese	44	14000	588	142.079545	1.42E+02	146.8602	2	2	yes	None	
Mercury	44	34	0.11	0.01553568	1.55E-02	0.018274	2	2	yes	None	
Methyl ethyl ketone	44	440000	0.135	0.01103636	1.10E-02	0.020764	2	2	yes	None	
Methylene chloride	44	7300	0.0199	0.00505284	5.05E-03	0.002869	2	2	yes	None	
Nickel	44	1400	23.5	3.90636364	3.91E+00	4.871046	2	2	yes	None	
Selenium	44	2700	2.2	0.29460227	2.95E-01	0.384345	2	2	yes	None	
Silver	44	350	1.3	0.13110227	1.31E-01	0.246449	2	2	yes	None	
Toluene	44	59000	0.0376	0.00201023	2.01E-03	0.005574	2	2	yes	None	
Vanadium	44	330	58.9	10.2477273	1.02E+01	12.27862	2	2	yes	None	
Zinc	44	76000	896	1.69E+02	1.69E+02	227.274	2	2	yes	None	
AOC-3:Sediment number of additional samples needed for Human Health Risk Evaluation										0	

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Constituent	Quantity of Phase I samples	Concentration (mg/kg)					Sample Size Method 1	Sample Size Method 2	Statistical Power? [3]	Proposed quanity of additional samples to collect[4]	Notes
		Bench-mark	Max	Mean	95th UCL of Mean	St Dev	VSP calculated quantity of samples: Δ=sample mean-benchmark [1]	VSP calculated quantity of samples: Δ = 50% of benchmark [2]			
AOC-3: Sediment- Ecological											
Arsenic	44	8.2	17.3	2.53068182	2.53E+00	2.988662	4	6	yes	None	
bis(2-Ethylhexyl)phthalate	44	0.182	0.729	0.10309943	1.03E-01	0.132826	26	20	yes	None	
Cadmium	44	1.2	0.67	0.12034091	1.20E-01	0.133983	2	2	yes	None	
Chromium	44	81	29.9	6.34772727	6.35E+00	7.124132	2	2	yes	None	
Copper	44	34	57.1	7.54659091	7.55E+00	10.80207	3	5	yes	None	
Lead	44	46.7	34.1	8.56477273	8.56E+00	7.705635	2	3	yes	None	
Mercury	44	0.15	0.11	0.01553568	1.55E-02	0.018274	2	2	yes	None	
Methylene chloride	44	3.82	0.0199	0.00505284	5.05E-03	0.002869	2	2	yes	None	
Nickel	44	20.9	23.5	3.90636364	3.91E+00	4.871046	3	4	yes	None	
Silver	44	1	1.3	0.13110227	1.31E-01	0.246449	3	4	yes	None	
Toluene	44	0.94	0.0376	0.00201023	2.01E-03	0.005574	2	2	yes	None	
Zinc	44	150	896	1.69E+02	1.69E+02	227.274	1262	80	no	None	1
AOC-3:Sediment number of additional samples needed for Ecological Risk Evaluation										0	
Total AOC-3: Sediment number of additional samples needed for Human Health and Ecological Risk Evaluation										**0**	

1 - D = the difference between the sample mean and the benchmark, page 107 – 108 of Guidance on Systematic Planning Using the Data Quality Objective Process, EPA QA/G4, February 2006, http://www.epa.gov/QUALITY/qs-docs/g4-final.pdf

2 - D =50% of threshold chosen in accordance with VSP User Guide, Version 5.0, September 2007, page 3.7, "[Delta] *probabilities are 20% to 95%* [of threshold]*, i.e. from beta to 1-alpha … Determining a reasonable value for the size of the gray region calls for professional judgment and cost/benefit evaluation.*"

3 - statistical power is achieved when either the null hypothesis is rejected or the sample size equation indicates a sample size less than the number of Phase I samples, in this case we are focusing on the number of samples

4 - the minimum number of samples between the two methods is used to indicate if samples are needed based on the specific chemical, the VSP recommended sample size is used or professional judgement, (see notes next column), when sampling is conducted for that chemical, other analyses will be run.

Notes:

1. Zinc: the Method 1sample size equation indicates a large number of samples are recommended to detect a difference between the mean of the site and the benchmark, while Method 2 indicates a smaller number of samples to detect a difference of 1/2 the benchmark. The Method 2 number still seems too high given that the current hypothesis tests show there is one statistical outlier skewing the parameteric sample size test and that the null hypothesis that the site is dirty could be rejected using the nonparametric test (see VSP output), additional samples would not likely change the outcome. For this reason and the fact that Zinc is a naturally occurring metal and may not be different from background, additional samples are not proposed.

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APPENDIX E

STANDARD OPERATION PROCEDURE 21 (SOP)

SURFACE WATER SAMPLING

INTRODUCTION

The Work Plan will indicate the surface water sampling locations and reasoning based on point source discharges, non-point source discharges and type of surface water body.

Wading for surface water samples in lakes, ponds, bays and slow-moving rivers and streams will be performed with caution to minimize disturbance of sediment. All surface water samples are to be obtained from the most downstream sample to avoid sediment interference.

SAMPLING RATIONALE/APPROACH

Lakes, Ponds, Bays and Impoundments

Sample selection should adequately represent the conditions of the lake, pond or bay. Identify intakes and outflows which provide biased sample representation.

The number of water sampling sites on a lake, pond, or impoundment will vary with the purpose of the investigation, as well as the size and shape of the basin.

When collecting sediment samples in lakes, ponds, and bays, samples should be obtained at locations noted in the Work Plan.

In all instances, the sampling locations should be properly documented with field notes and photographs.

SAMPLING TECHNIQUES

When collecting surface water samples, direct dipping of the sample container into the water is acceptable unless the sample bottles contain preservatives. If the bottles are preserved, then precleaned unpreserved bottles should be used to collect samples. The water sample should then be transferred to the appropriate preserved bottles.

When collecting samples, submerse the inverted bottle to the desired sample depth and then tilt the opening of the bottle upstream to fill. Compositing across a stream and/or water channel is typically performed using a pre-rinsed 1 to 2 L plastic bottle collecting sub-samples for final mixing sample aliquot collection. VOC's must not be collected from the compositing bucket and are sampled directly from the stream cross section.

Wading may disturb sediment and could result in a biased sample. Wading is acceptable if the stream has a noticeable current and the samples are collected directly into the bottle while pointed upstream. If the stream is too deep to wade or if the sample must be collected from more than one water depth, additional sampling equipment will be required. Samples should be collected approximately 6 inches (15 cm) below the surface with the sample bottles completely submerged. This will keep floating debris from entering the sample bottles. Floating debris could result in unrepresentative analytical data.

Teflon bailers may be used for surface water sampling if it is not necessary to collect a sample at a specified interval. A top-loading bailer with a bottom check-valve is sufficient for many studies. As the bailer is lowered through the water, water is continually displaced through the bailer until a desired depth is reached, at which point the bailer is removed. This technique is not suitable where strong currents are encountered (because the ball may not seat effectively), or where a discrete sample at a specific depth is required.

A glass beaker or stainless steel scoop may be used to collect samples if the parameters to be analyzed are not interfered with. The beaker or scoop should be rinsed three times with sample water prior to collection of the sample. All field equipment should follow standard cleaning procedures.

EQUIPMENT/MATERIALS

- Sampling device (Plastic bucket, pump, depth integrated sampler (D15))
- Flow measurement device (velocity meter, survey equipment, measuring tape)
- Sampling materials (sample containers, log book, cooler, chain-of-custody)
- Camera
- Work Plan
- Health and Safety Plan

In accordance with the Field Sampling Plan (FSP) and FSP Addendum No. 1, additional sampling required for surface water shall include analyses for total and dissolved metals using techniques as recommended in *Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods*, Chapter 5; RG-415; October 2008. These procedures are outlined below.

Metals-in-Water Samples

Basic metals-in-water monitoring focuses on the TSWQS for the protection of aquatic life.

Routine Status Monitoring for Metals

For routine status monitoring (sometimes called “TSWQS metals”), collect samples for *dissolved* and *total metals*. Routine dissolved metals include arsenic, cadmium, chromium, copper, iron, lead, magnesium, manganese, nickel, selenium, silver, and zinc. Routine total metals include only selenium and mercury.

Routine metals-in-water samples are not collected during periods of abnormally high turbidity associated with high or flood flows. Samples with high turbidity are unstable, making it difficult to collect a representative grab sample of soluble metals. High suspended solids can also interfere with the sample analysis. However, metals should be collected at sites that are normally turbid, but special-study sampling may be an exception. For example, wet-weather sampling is likely to include some samples with high turbidity. Delay sampling for metals for at least 48 hours following a heavy rainfall.

Sample-Collection Depth

Collect a metals sample from a depth of 0.3 m, using a peristaltic pump or other pumping system. Near-surface water is considered representative of the water mass in all water-body types. For determining compliance with numerical toxic-substance standards, a sample taken at the surface (as previously defined) is adequate.

Sampling Equipment

Store and transport syringes, 0.45 micron (µ) filters, gloves, and any other sampling supplies in dust-free containers, such as plastic bags, included in laboratory-prepared sampling kits.

Field Filtration

Sample filtration for dissolved metals must be performed in the field within 15 minutes of collection and with extreme care to avoid contamination. If samples are allowed to sit for an extended period of time, metals will settle out or adhere to the sides of the plastic container. Pump and filter samples directly into their container.

Sample Containers

Total metals, dissolved metals and associated blank samples generally require a 250 mL plastic bottle. For mercury only, use a 250 mL glass or Teflon bottle. Store and transport containers so they stay dust-free.

Labeling the Sample Container

Do not write on the sample container. Write the sample information on the plastic bag holding the sample container. Provide enough information for the laboratory receiving the sample to easily match it to the analysis request or chain of custody (for example, date, location, type of sample). For the dissolved metals-in-water sample indicate that the sample has been field filtered.

Sample Preservation

Metals-in-water samples are preserved with a 1:1 HNO3/H2O solution made from metals-grade HNO3 and metals-free deionized water. To eliminate potential contamination in the field, metals-in-water samples are shipped to the lab unpreserved. Samples are preserved upon arrival at the laboratory. The lab will add acid to bring the pH down to < 2. The holding time for acid-preserved samples is six months, except for mercury—28 days.

Equipment Preparation

Metals-in-water sampling materials must be prepared by a laboratory that can perform adequate quality-control checks. A standard metals-in-water sample-collection kit contains the following items.

- 250 mL plastic bottles (dissolved-metals blank, dissolved-metals sample, total-metals sample) in plastic bags
- 250 mL glass bottles (mercury blank and sample) in plastic bags

- 0.45 μ metals-free cartridge filter
- 60 mL plastic syringe or piece of clean Teflon tubing (for use with peristaltic pump) in plastic bags
- 1 L bottle of blank water
- plastic bag (3' x 3') to be used as a ground cloth
- powder-free gloves

Blank Water
Take an adequate supply of metals-free deionized water into the field for each field blank collected. Metals-free deionized water is supplied by the laboratory performing metals analysis. Keep the deionized-water containers clean and dust-free on the outside by wrapping them in plastic bags.

Companion Samples for Metals in Water
Request total-hardness analysis whenever metals in water are to be analyzed from an inland site (estuarine sites do not require hardness analysis).

Typically, hardness can be calculated from the analysis of calcium and magnesium. The same sample used for total metals may also be used for hardness. If a *total-metals sample* is collected, submit a sample for total suspended solids (TSS) if not already requested in a companion sample for routine water chemistry.

See Table 4 for sample volumes, containers, preservatives, and holding times for hardness and TSS samples.

Clean Hands / Dirty Hands Sampling
Total- and dissolved-metals sampling procedures are based on EPA Method 1669 (EPA 1996). Clean sampling procedures, including *Clean Hands* (CH) / *Dirty Hands* (DH) techniques, are required when collecting samples for metals and other trace elements. *CH/DH* techniques require two people working together. At the field site, one person is designated as *CH* and the second as *DH.* Although specific tasks are assigned at the start, some tasks overlap and can be handled by either *CH* or *DH* as long as no contamination is introduced into samples. Both *CH* and *DH* wear non-contaminating, disposable, powder-free gloves during the entire sampling process and may change gloves frequently as the tasks change. Specifically, *CH* changes gloves between samples and whenever anything not trace-metals clean has been touched. *CH* takes care of all tasks involving direct contact with the sample bottle and transfer of sample from the collection device to the bottle. *CH* generally works inside a clean area, usually inside a large plastic bag near the water body (see Figure 5.2) or inside a vehicle. *DH* works outside of the clean area on tasks such as preparing the sampler, operating sampling equipment, and all other activities that do not involve direct contact with the sample.

Avoiding Contamination
The key to collecting a good metals-in-water sample is to avoid potential sources of contamination. Collect samples upstream from bridge crossings. Whenever possible, collect samples facing upstream and upwind to minimize contamination. Other sources of contamination to avoid include airborne dust, automobile exhaust, cigarette smoke,

and nearby corroded and rusty bridges, pipes, poles, or wires. Mark sample information on the plastic bag and not on the bottle.

Look for ways to reduce the number of sample handling steps. This is not generally an issue when collecting a sample with a peristaltic pump, tubing, and a 0.45 μ cartridge filter. A large volume of water can be processed quickly filling sample containers directly from the water body.

However, using a 60 mL syringe requires multiple steps to fill the syringe and filter sample to obtain the appropriate volume. The potential for introducing unwanted contaminants is high. An efficient way to reduce the number of sample handling steps is to use a larger laboratory prepared container to collect the sample. An empty blank water container can be used to collect the ambient water sample. This supplies a large volume of sample allowing the entire filtering process to be done inside the clean area.

Metals-in-Water Collection Procedures

Metals sampling procedures are based on EPA Method 1669 (EPA 1996). The following section outlines sample collection using the traditional EPA Method 1669—peristaltic pump, tubing, and cartridge filter.

Total-Metals Sample

At the site *DH* opens the outer, dirty bag holding the total-metals sample bottle while avoiding contact with the clean inner bag (if present). *CH* opens the inner bag (if present) and pulls out the sample bottle. *CH* does not touch anything but the sample bottle, the cap, and the water being sampled. *CH* opens the bottle, making sure not to lay the cap on any surface while off the bottle. For a total-metals sample, fill the container directly from a water body or from a precleaned sample collection device. To reduce contamination, containers can be filled and capped under the surface of the water. Allow enough space for the addition of acid. Samples are preserved by the laboratory performing the analysis. *CH* places the container back in the plastic bag and sealed by *DH*. The holding time for preserved metals samples is six months. Follow the same process for a total-mercury sample. Allow enough space for the addition of acid. Mercury samples are preserved by the laboratory doing the analysis. The holding time for a preserved mercury sample is 28 days.

Dissolved-Metals Sample

At the site, *DH* sets up the pump, while *CH* places the bottle in a *container holder*—anything nonmetal that supports the bottle, freeing up the collector=s hands. *DH* opens the bag containing the filter. *CH* takes an end of the tubing and attaches the 0.45 μ cartridge filter making sure the flow arrow points in the correct direction. The filter end is approximately 18 inches from the pump, and the other end is long enough to easily reach beneath the water surface. *DH* closes the pump head, locking the tubing in place.

DH pulls the dissolved sample container from the cooler and opens the outer, dirty bag while avoiding contact with the clean inner bag (if present). *CH* opens the inner bag (if present) and pulls out the sample bottle. *CH* does not touch anything but the sample bottle, the cap, and the water being sampled.

DH immerses the intake tube directly into the water and operates the pump. *CH* allows the ambient water to flush the tube and filter with the filter held upright. This allows water to run over the filter and remove any dirt or dust particles that might be on the filter. *CH* removes the cap from the sample bottle, holds the filter over the container opening, and allows the container to fill, leaving some head space. CH puts the cap back on the bottle and places the bottle back inside the plastic bag. DH seals the bag and places it in the ice chest. Whenever *CH* touches the boat or equipment, which may be contaminated, *CH* should change gloves immediately.

Requirements for Collecting QC Samples for Metals in Water

In order to detect contamination in the sampling process, blanks are submitted for analysis. Run a blank for each type of metal sample collected. Field blanks (FB) are required for total-metals samples; equipment blanks (EB) for dissolved-metals samples.

Field-Equipment-Blank Collection Procedure

Collect field equipment blanks—following the same procedure used to collect the ambient sample—at the last site of a sampling day or run. The same tubing (or syringe) and filter can be used to collect an ambient sample.

Companion Samples for Metals in Water

Request total-hardness analysis whenever metals in water are to be analyzed from an inland site (estuarine sites do not require hardness analysis). Typically, the hardness can be calculated from the analysis of calcium and magnesium. The same sample used for total metals may also be used for hardness. If a total-metals sample is collected, submit a sample for total suspended solids (TSS) if not already requested in a companion sample for routine water chemistry. See Table 5.1 for sample volumes, containers, preservatives, and holding times for hardness and TSS samples.